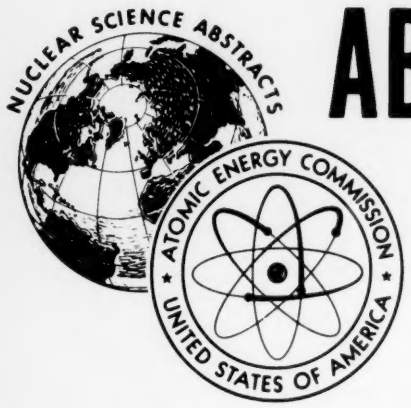
NUCLEAR SCIENCE ABSTRACTS



Volume 28 Number 8

Abstracts 17837-20663

October 31, 1973

UNITED STATES ATOMIC ENERGY COMMISSION

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Volume 28, Number 8, October 31, 1973

NUCLEAR SCIENCE ABSTRACTS

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Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

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ACETONE/RADIOLYSIS
  Pulse radiolysis of alkyl ketones, 27:24388
  Radiothermoluminescence of aliphatic ketones (Gamma radiation), 27:24389
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is indexed as:

OAK RIDGE NATIONAL LAB., TENN.
  Gamma-ray production due to neutron interactions with copper for incident neutron energies between 1.0 and 20 MeV: tabulated differential cross sections, 27:21102 (ORNL-4846)

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  4840 **27-19984** **Dep. NTIS, 8p.**
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Dissertations from *Dissertation Abstracts International, Part B* that are included in *Nuclear Science Abstracts* are available from University Microfilms, Inc., 315 N. First Street, Ann Arbor, Michigan 48103.

Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

17837 166TH NATIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY, CHICAGO, ILLINOIS, AUGUST 26–31, 1973. Abstracts of Papers. Washington, DC; American Chemical Society (1973). 636p. (CONF-730807-(Abstrs.)). $9.00.

From 166th American Chemical Society national meeting; Chicago, Illinois, USA (26 Aug 1973).

Analytical and Separations Chemistry

Refer also to abstracts 18173, 18392, 18583, 18655–18657, and 19967.

17838 (GSF-S-188) ANALYTICAL METHODS IN ENVIRONMENTAL CONTROL. Sansoni, B. (Gesellschaft fuer Strahlen- und Umweltforschung M. B. H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz). Jul 1972. 25p. (In German). INIS.

This report deals with the methods of environmental control, particularly the trace analysis of radionuclides and chemical elements. The single steps of a trace analysis, i.e., sampling, ashing of biological materials, chemical enrichment and separation, sample preparation and, finally, physical (predominantly spectroscopical) measurements and evaluations are discussed. (INIS)

17839 POST-IRRADIATION CHEMICAL ANALYSIS. Foster, E.; Fudge, A. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 219-226 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Chemical analysis is a necessary part of any examination of irradiated materials. The study of the properties of nuclear fuels must always be related to the burnup they have received. Burnup can only be determined accurately by chemical methods. The analysis of reactor materials for fission product release and redistribution is important, and the chemical analysis of canning materials is sometimes necessary to determine their degree of interaction with the fuel. The techniques and facilities developed for chemical analysis of all types of reactor materials under remote conditions are described. (auth)

17840 TECHNIQUE FOR TRITIUM MEASUREMENT IN IRRADIATED FUEL PINS. Terzaghi, A.; Henrion, P.; Koch, G. (Centre d'Etudes de l'Energie Nucleaire, Mol, Belgium). pp 143-147 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Preliminary experiments in collecting and measuring tritium liberated from irradiated oxide fuel pins during puncture tests have been performed. Results are seriously influenced by the cold-trapping technique used to collect small amounts of tritium in condensable form. A critical analysis of the system and the improvements which are envisaged is presented. (auth)

17841 INTERNATIONAL CONGRESS ON ANALYTICAL CHEMISTRY, Kyoto, Japan, April 3–7, 1972. Abstracts. Oxford; International Union of Pure and Applied Chemistry (1972). 598p. (CONF-720477-(Abstrs.)).

Activation and Nuclear Reaction Procedures

Refer also to abstracts 18247, 18462, 19157, and 20616.

17842 (AAEC/LIB/Bib-378) NUCLEAR ANALYSIS IN GEOLOGY AND GEOCHEMISTRY. A Bibliography. Newland, E. A. (comp.). (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1973. 117p. Dep. NTIS (U. S. Sales Only) $8.00.

A bibliography is presented containing 511 references covering the period 1967–1972 from Geophysics Abstracts and NSA. Arrangement is alphabetical by author within each year and is divided into general references and references on borehole logging. A citation of an abstract for each reference is given. (auth)

17843 (BMBW-FBK-72-13) ACTIVATION ANALYSIS. First Seminar, Garching, December 8, 1970. Born, H. J. (ed.). (Technische Universitaet, Munich (West Germany). Institut fuer Radiochemie). Aug 1972. 100p. (In German and English). CONF-701232-).

An abstract was prepared for each of the six papers presented. (DHM)

For abstracts of individual papers see: 17844–17849.

17844 (BMBW-FBK-72-13, pp 1.1-1.13) ANALYTICAL USES OF PROMPT γ RADIATION. Henkelmann, R. Aug 1972. (In German).

From 1st seminar on activation analysis; Garching, Germany (8 Dec 1970).

Thermal neutron capture experiments were performed in an external channel of the Munich research reactor. The thermal neutron flux was 2×10^7 cm^{-2} sec^{-1}. The prompt gamma spectra of samples were recorded with a Ge(Li) detector. Under these conditions, a sensitive determination was possible for boron, cadmium, and a number of the lanthanide elements. Practical application of the method comprised the determination of boron in glass and steel, the distribution of rare earth elements in minerals and ores, the determination of cadmium, the study of reactor structural elements, and the examination of isotope ratios for numerous isotopes. (HBG)

17845 (BMBW-FBK-72-13, pp 2.1-2.29) MONOSTANDARD ACTIVATION ANALYSIS AND ITS APPLICATION TO THE GEOLOGICAL SAMPLES: INVESTIGATION OF SCHEELITE DEPOSITS IN THE EAST ALPS. Kim, J. I.; Staerk, H. Aug 1972.

From 1st seminar on activation analysis; Garching, Germany (8 Dec 1970).

The monostandard method with the use of the Ge(Li)-gamma spectrometry was studied by critical evaluation of nuclear data involved in activation and activity measurement. The method is applied to investigate the scheelite deposits in the East Alps. While determining W contents in 18 samples of different origin, 14 other elements which are usually involved with scheelite deposits are also simultaneously analysed. The results are compared with those from the relative method in order to prove the accuracy and reproducibility of the monostandard technique. (auth)

17846 (BMBW-FBK-72-13, pp 3.1-3.13) COMPUTER EVALUATION OF Ge(Li)-REGISTERED GAMMA SPECTRA FOR INSTRUMENTAL MULTI-ELEMENT ACTIVATION ANALYSIS AND CONSIDERATIONS ON THE USE OF ACTIVATION ANALYSIS FOR INSTRUMENTAL, AUTOMATED CHIEF CONSTITUENT DETERMINATION. Lux, F.; Gierl, A. Aug 1972. (In German).

From 1st seminar on activation analysis; Garching, Germany (8 Dec 1970).

A new computer program was developed for the automated determination of several elements in the gamma spectrum after neutron activation. The first step searches and registers the gamma

peaks as well as their intensities and energies. The second step determines the elements qualitatively. The third step determines the elements quantitatively. The first step is accomplished by means of the second derivative of the spectrum. The second step compares four gamma peaks for each element with respect to energy and relative intensity. The third step measures the corresponding peak areas of the detected elements. The application of the procedure for nondestructive testing of various materials is discussed. (HBG)

17847 (BMBW-FBK-72-13, pp 4.1-4.18) SPECIAL APPLICATIONS OF ACTIVATION ANALYSIS TO THE QUESTIONS OF INDUSTRY, AGRICULTURE, AND GEOLOGY. Staerk, H. Aug 1972. (In German).

From 1st seminar on activation analysis; Garching, Germany (8 Dec 1970).

In both fresh and freeze dried samples of various vegetables, the bromine content was determined by neutron activation analysis. After disinfection of the soil with methylbromide, the bromine content in plants increased by a factor of 1000. This high increase was not prevented by strong rains. Therefore, methylbromide treatment of soil should be performed cautiously. To apply the sterile male technique to certain local fruit flies, preliminary studies were done which involved labeling of larvae with Mn and several rare earth elements. By subsequent activation analysis, the flight patterns and the distribution of the animals could be followed. Because of the possibility that the Eastern Alps might contain large tungsten deposits, a simple activation analysis method was developed for scheelite ($CaWO_4$). With high resolution Ge(Li) detectors, 0.01 to 5 percent of WO_3 could be determined, as well as Cr and Sc. (HBG)

17848 BMBW-FBK-72-13, pp 5.1-5.13) ACTIVATION ANALYSIS USING SHORT-LIVED NUCLIDES. Henkelmann, R. Aug 1972. (In German).

From 1st seminar on activation analysis; Garching, Germany (8 Dec 1970).

Short-lived nuclides were studied in the fast pneumatic tube of the Munich research reactor. The fast neutron flux amounted to about 10^{12} cm^{-2} sec^{-1}. The sample carrying rabbits reached the measuring position within 0.8 seconds after irradiation. Gamma spectra were obtained with a NaI(Tl) scintillation crystal and a multichannel analyzer. Detection thresholds were as follows: $^{16}O(n,p)$ 200 μg; $^{19}F(n,\gamma)$ 1 μg; $^{89}Y(n,n')$ 0.5 μg; $^{207}Pb(n,n')$ 200 μg. (HBG)

17849 (BMBW-FBK-72-13, pp 6.1-6.8) CALIFORNIUM-252 AS A NEUTRON SOURCE FOR ACTIVATION ANALYSIS. Hoehlein, G. Aug 1972. (In German).

From 1st seminar on activation analysis; Garching, Germany (8 Dec 1970).

Application possibilities for ^{252}Cf as neutron source in activation analysis are reviewed. In-line and on-line analyses are discussed as well as the measurement of prompt gamma emission and of delayed gamma and neutron emission. Activation in boreholes is discussed for such metals as Ag, Ni, Fe, Zn, Mn, Cr, and U. Also discussed are continuous monitoring of sulfur content in coal and oil; the analysis of sediments on the sea floor; and the control of fissionable material in the laboratory, reprocessing plants, and fuel element fabrication. For medical purposes, ^{252}Cf activation can produce such short-lived isotopes as ^{38}Cl, ^{60m}Co, ^{56}Mn, ^{64}Cu, ^{65}Ni, ^{80}Br, ^{128}I, ^{134m}Cs, ^{139}Ba, and ^{165}Dy. (HBG)

17850 (CONF-730817-1) ANALYTICAL TECHNIQUES FOR DETERMINING LEVELS AND FATES OF TRACE ELEMENTS IN A FOSSIL-FUELED STEAM PLANT. White, J. C.; Lyon, W. S.; Carter, J. A.; Feldman, C.; Shults, W. D. (Oak Ridge National Lab., Tenn.). 1973. 25p. Dep. NTIS $3.25.

From symposium on nuclear techniques in comparative studies of food and environmental contamination; Otaniemi, Finland (27 Aug 1973).

Advantages and limitations are given for analytical techniques used in a study of trace elements flow within a fossil-fueled steam power generation plant. Nondestructive, absolute neutron activation analysis (NAA) was used insofar as possible in order to obtain maximum information at minimum cost. The stable isotope dilution technique was used with spark-source mass spectrometry (SSMS) for several elements, in order to obtain accurate trace element levels. Atomic absorption was used for specific elements that are determined with some difficulty by NAA and SSMS, e.g., mercury. Electron spectroscopy and scanning electron microscopy were also used, primarily for studies of particulate matter. (DHM)

17851 (COO-3126-21) PROGRESS REPORT FOR THE PERIOD JUNE 1, 1972-MAY 31, 1973. Finston, H. L. (Brooklyn Coll., N. Y. Dept. of Chemistry). [nd]. Contract AT(11-1)-3126. 20p. Dep. NTIS $3.00.

Research progress is reported in the following areas: thermal neutron cross sections of some reactor produced radionuclides; environmental activation analysis (mercury determination by x-ray counting, trace elements in marine and biological samples, and trace elements in motion vehicle exhaust and atmospheric samples); and solvent extraction research. (DHN)

17852 (FRNC-TH-287) DETERMINATION OF C, N, AND O USING $^{12}C(\alpha,n)^{15}O$, $^{14}N(d,n)^{15}O$, AND $^{16}O(\gamma,n)^{15}O$ NUCLEAR REACTIONS. Mayolet, F. (Paris Univ. (France)). 1972. 86p. (In French). NTIS (U. S. Sales Only).

Thesis.

The irradiation of Si, steels, Ta, Mo, Pb, and Cu with 35 to 40 MeV γ rays can be used as a rapid method for determining O in these substances. The $^{16}O(\gamma,n)^{15}O$ reaction predominates over interfering reactions with adjacent elements. The $^{14}N(d,n)^{15}O$ reaction is specific for the determination of N. A good sensitivity (10^{-3} μg) is achieved when steel samples are irradiated with deuterons having energies of less than 10 MeV, the principal competitive reaction on O being eliminated. The $^{12}C(\alpha,n)^{15}O$ reaction only enables C to be determined in Ta and Fe samples irradiated with 16 MeV α particles, because of the other competitive nuclear reactions occurring on N and O. Thus a significant loss in sensitivity occurs. However, for the cases where the sample contains low O and N contents in relation to its C content, irradiations can be performed with particles having higher energies and a gain in the sensitivity and the thickness analyzed can be achieved. As irradiation strongly activates most of the elements, it is imperative that the ^{15}O (half life of 2.03 minutes) is separated after irradiation. A rapid reducing fusion method of chemically separating ^{15}O was investigated in view of fulfilling this requirement. (Fr)

17853 (IRI-133-72-11) PATTERN RECOGNITION AS A STATISTICAL METHOD FOR ANALYZING THE CONFIDENCE LEVEL IN THE IDENTIFICATION OF OBJECTS. de Bruin, M.; Korthoven, P. J. M.; Duin, R. P. W.; Groen, F. C. A.; Bakels, C. C. (Interuniversitair Reactor Instituut, Delft (Netherlands)). 1972. 21p. Dep. NTIS (U. S. Sales Only) $3.25.

A statistical identification method to be used with nondestructive neutron activation is described that is basically a pattern recognition procedure. In this procedure, each sample is represented by a point in a multidimensional concentration space. From the analytical data of groups of training samples from various relevant origins, the multidimensional probability distribution for each origin can be constructed. Then, an unknown sample can be assigned to a specific origin which provides the highest probability for the occurrence of such a sample. The position of the sample in the probability distribution of the assigned origin yields information about the confidence level of the identification. The method was developed and tested for the identification of flint artefacts but would seem to be very well applicable to the forensic identification of mineral and biological samples. (auth)

17854 DETERMINATION OF VANADIUM, ZIRCONIUM, HAFNIUM, AND TANTALUM IN TIN ORES BY NEUTRON ACTIVATION ANALYSIS. Djojosubroto, H.; Usman, J. E.; Zahiruddin (Bandung Reactor Centre, Indonesia). Radiochem. Radioanal. Lett.; 14: No. 4, 257-263(30 Jul 1973).

Vanadium and tantalum were determined in cassiterite and tin-mine slags by nondestructive neutron activation analysis using γ-ray spectrometry. Zirconium and hafnium were also determined, using a simple radiochemical purification step, but niobium could not be found owing to its short half-life. (auth)

17855 DETERMINATION OF TRACE ELEMENTS IN TIN BY REACTOR NEUTRON ACTIVATION ANALYSIS. Maenhout, W. Ghent; Ghent Rijksuniversiteit (1972). 193p. (In Dutch).

Thesis.

The determination of trace elements in tin by reactor neutron activation analysis was studied. Some interference reactions of importance were also investigated. Three analytical methods were developed. In the first of these indium and manganese were determined by means of the radioactive isotopes $^{116m1}In$ and ^{56}Mn. The second method involved separation of the tin and ^{125}Sb matrix activities from the non-volatile impurities by distillation from a $HBr-H_2SO_4$ medium. Ge(Li) gamma spectrometry of the residue then allowed the determination of copper, silver, sodium, cadmium, gallium, lanthanum, tungsten, indium, cobalt, iron, nickel, zinc, chromium and scandium. From the results it appeared that certain contaminations are especially important in analysis of high-purity (99.9999% and 99.999%) tin. Surface contaminations were etched off with boiling hydrochloric acid, but not always with the desired result. Because theoretical calculation of interferences requires knowledge of appropriate cross sections, these were determined for the reactions $^{112}Sn(n,\gamma)^{113}Sn$, $^{114}Sn(n,p)^{114m1}In$, $^{118}Sn(n,\alpha)^{115}Cd$ and $^{112}Sn(n,2n)^{111}Sn$. The last of these is responsible for the ^{111}In activity in the distillation

residue of the second method, by decay of ^{111}Sn($T_{½}$ = 35.1 min) to ^{111}In($T_{½}$ = 2.82 d). (BE)

17856 DETERMINATION OF EUROPIUM, HOLMIUM, AND TERBIUM IN THULIUM OXIDE BY THE NEUTRON ACTIVATION METHOD. Antonov, A. V.; Vozhzhov, V. F.; Kim, Yu. S.; Moiseev, V. E. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 910-912(1972).

Translated from Radiokhimiya; 14: No. 6, 880-882(1972).

A method of neutron activation in the determination of europium, holmium, and terbium in thulium oxide was developed. The sensitivity of the determination of europium (5×10^{-6}%) was estimated under the condition of a content of 1×10^{-3}% of an interfering terbium impurity in the samples. The sensitivity of the determination of holmium (2×10^{-4}%) was estimated in the presence of a content of 1×10^{-4}% europium and 5×10^{-4}% sodium in the samples. The determination of terbium (down to 2×10^{-4}%) was performed after six days under conditions of total decay of interfering impurities. The contributions of interfering impurities in the analytical regions of the elements to be determined were calculated for various times of exposure of the samples after irradiation. (auth)

17857 ANALYTICAL POTENTIALITIES OF THE BETATRON WITH INTRACHAMBER IRRADIATION. IV. Accuracy and Sources of Errors. Kuznetsov, R. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 906-909(1972).

Translated from Radiokhimiya; 14: No. 6, 876-879(1972).

Results of an investigation of the general accuracy of instrumental photoactivation analysis using intrachamber bremsstrahlung irradiation on a betatron and the possible sources of errors are reported. It is noted that because of the limited dimensions of the radiation beam, stringent maintenance of size and shape of the samples to be irradiated is necessary. A radiation monitor of Cu, polyethylene film, or certain other materials is advised since work of the betatron is also characterized by substantial dispersion of the average radiation intensity from one irradiation to another and fluctuations of the intensity during the irradiation of the sample. A relative quadratic error of 2.6% is reported in a determination of high contents of well-activated elements in pulverized samples packed into aluminum cuvettes. The error for analysis of samples in the form of standard tablets was 1.5 to 2%. (JGB)

17858 DETERMINATION OF CARBON, OXYGEN, AND NITROGEN CONTENTS IN HEMATOMELANIC ACID USING A PHOTONUCLEAR REACTION. Kasymov, A. K.; Khakimov, M.; Miller, R. A. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 10, 23-24(1972). (In Russian).

The photonuclear (γ,n) reaction of the isotopes ^{12}C, ^{16}O, and ^{14}N which produces the positron-active ^{11}C, ^{15}O and ^{13}N was employed in a determination of the content of C, O, and N in hematomelanic acid. The γ-activation method yielded the values for C, O, and N: 61.6, 29.2, and 1.89%; conventional chemical analyses yielded 61.8, 32.5, and 2.4%. (KSW)

17859 RADIOANALYTICAL METHODS DEVELOPED IN HUNGARY. Banyai, E. (Budapest Technological Univ.). Kem. Kozlem.; 38: No. 4, 382-396(1972). (In Hungarian).

Radioanalytical methods developed in Hungary are reviewed under the headings: activation analysis, separation methods, radiorelease, and radiation absorption. Of the 169 references, the majority are in Hungarian journals. (TTT)

17860 MERCURY: ENVIRONMENTAL CONSIDERATIONS. Part I. Krenkel, P. A. (Vanderbilt Univ., Nashville). CRC Crit. Rev. Environ. Contr.; 3: No. 3, 303-373(May 1973).

The mercury environmental problem is discussed from an engineering standpoint and an attempt is made to rationally present the significance of recently found mercury in the environment in view of the existing knowledge of this ubiquitous material. The development and extent of mercury's presence in the environment are presented and the various sources of mercury to the environment are elucidated. Differentiation between man's contribution to the mercury in the environment and natural contributions is made and examples are given of the relative contributions of each source. The distribution of mercury in the environment is discussed and review of the literature is used in order to establish reasonable background levels in each phase of the environment. Mercury in fish is given particular attention, with regard to both existing concentrations and background levels. Today's mercury concentrations are placed in perspective with those found in samples taken from museum species many years ago. The implications of the assumption by the Food and Drug Administration that all of the mercury in fish is methylmercury are also discussed. A comprehensive review of total mercury analyses and methylmercury analyses is presented including discussions of various methodologies utilized, including neutron activation and x-ray fluorescence methods. (DHM)

17861 NONDESTRUCTIVE ACTIVATION ANALYSIS FOR GOLD, MANGANESE, AND SODIUM IN GOLD ORES. Sakai, K.; Takahashi, S. (Tokai Univ., Tokyo). Tottori Daigaku Kyoikugakubu Kenkyu Hokoku, Shizenkagaku; 1972: No. 2, 59-64(Mar 1973). (In Japanese).

A method is described for determining gold, manganese, and sodium in gold ores by means of nondestructive neutron activation analysis using a 400 channel γ-ray pulse height analyzer. The samples are irradiated over one to ten h in the research reactor, i.e., HTR, whose thermal neutron flux amounts to 2.6×10^{11} n/cm^2 sec. The trace amounts of the elements in gold ore samples are determined by comparing their half lives and energy spectra with those in the standard samples. Each nuclide can be determined independently of their γ-energy spectra by selecting the pertinent irradiation and cooling time. (auth)

17862 MEASUREMENTS OF ^{12}C-, ^{14}N-, AND ^{16}O-CONCENTRATIONS IN WHEAT, BASED UPON PHOTON ACTIVATION. Spring, E.; Nikkinen, P. (Univ. Central Hospital, Helsinki). pp 76-79 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (Ed.). Helsinki; Technical Research Centre of Finland (1973).

From 1st national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121--.

Carbon-12-, ^{14}N-, and ^{16}O-concentrations in wheat were investigated by means of irradiation with high energy photons from a betatron. The ^{16}O-concentration was determined to be 40.5 ± 1.7%. The ^{14}N-concentration provided information on the protein content of the sample. The result arrived at in the measurements was 4.2 ± 0.2%. (JPL)

17863 ESSENTIAL AND ACCIDENTAL ELEMENTS IN HUMAN BLOOD. Brenner, M.; Henriksnaes, K. pp 115-117 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (Ed.). Helsinki; Technical Research Centre of Finland (1973).

From 1st national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121--.

Fifteen elements were determined in human blood samples by activation analysis using a Ge(Li) detector in a low-background room. The elements determined were Na, Sc, Fe, Co, Zn, Ga, Br, Rb, Sb, Ba, La, Ce, Nd, Sm, and Au. The blood samples were irradiated in the Triga reactor FIR1. (ERB)

17864 MEASUREMENT OF TOXIC HEAVY METALS BY NEUTRON ACTIVATION ANALYSIS. Eckhoff, N. D.; Clack, R. W.; Anthony, H. D.; Gray, A. P. (Kansas State Univ., Manhattan). Toxicol. Appl. Pharmacol.; 24: 178-181(Feb 1973).

Neutron activation analysis (NAA) was used to identify explicitly the causative agent in a case of suspected heavy element poisoning of livestock that conventional diagnostic techniques left unclear. NAA, using neutrons from a TRIGA Mark II Nuclear Reactor and a 25 cc germanium lithium-drifted semiconductor detector, sequentially revealed the absence of toxic concentrations of mercury in liver and kidney tissues of an affected carcass, then the absence of toxic amounts of arsenic, and finally the presence of antimony in quantities sufficient to have killed livestock. (auth)

17865 RADIOCHEMICAL ISOLATION OF FLUORINE BY ISOTOPIC EXCHANGE ON LANTHANUM FLUORIDE. Meshcheryakov, R. P.; Oblivantsev, A. N.; Rybasov, A. G.; Tronov, G. I. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 944-946(1972).

Translated from Radiokhimiya; 14: No. 6, 905-907(1972).

A method for the radiochemical isolation of ^{17}F based on the heterogeneous isotopic exchange of fluorine on a lanthanum fluoride precipitate is reported. The separation was used in the deuteron activation determination of oxygen in vanadium and copper. (JGB)

17866 SORPTION BEHAVIOR OF TRACE NUCLIDES IN SEA WATER ON MANGANESE DIOXIDE. Doshi, G. R.; Krishnamoorthy, T. M.; Sastry, V. N.; Sarma, T. P. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem.; 11: No. 2, 158-161(Feb 1973).

Adsorption behavior of 14 radionuclides, viz. Ce, Zr, Ru, Cs, Sr, Hf, Ag, Se, Zn, Co, As, Sb, Sn, and U, from sea water is studied on manganese dioxide precipitated in situ. Quantitative capture is found for Ce, Ru, Zr, Hf, Co, and Zn. Comparisons are made with the sorption capacity of ferric hydroxide for the same nuclides. The application of the in situ precipitation in the field of activation analysis and monitoring of radioisotopes released from nuclear installations is discussed. (auth)

17867 DETERMINATION OF INTERNAL AND SURFACE OXYGEN IN MOLYBDENUM USING 54 MeV α PARTICLES AND LOW ENERGY DEUTERONS. Faure-Mazagol, L. (Univ., Lyon);

Tousset, J.; Boissier, M. Analusis; 2: No. 4, 287-293(Apr 1973). (In French).

The application of two complementary techniques for the determination of oxygen in molybdenum by activation analysis is described. The surface oxygen and its diffusion profiles are determined by the direct observation of nuclear reactions (in the present case $^{16}O(d,p_1)$). The oxygen contents in the bulk of the sample are determined by activation analysis with 54 MeV α particles. Solvent extraction enables ^{18}F to be isolated and in this way the oxygen contents to be determined. (FR)

17868 IN VIVO NEUTRON ACTIVATION ANALYSIS. McNeill, K. G. (Univ. of Toronto). J. Inst. Nucl. Eng.; 14: No. 3, 84-86 (May 1973).

It is stated that whereas the main interest so far in the application of in vivo neutron activation analysis has been to determine the total amount of Ca in the body, variations of the method make it applicable to other elements, including P, I, N, Cl, H, and Na. The dose that the body need receive is <1 rem and the induced activity is of the order of tens of nanocuries. The case of Ca is discussed in detail, and comparisons made with other methods. Available neutron sources and neutron energies are listed and discussed. An important consideration is the total radiation dose given to the patient, and a surprising result is that for a given activity the dose received can be reduced by increasing the dose rate. The very sensitive counting apparatus required is also discussed, together with the transfer time of the patient from the irradiation chamber to the counting chamber in "off-line" measurements, and the use of "off-line" and "on-line" techniques, whilst the "off-line" technique is becoming well established, "on-line" methods are still in their early stages. Mention is made of problems arising due to the geometry of the subject, including size, weight, etc. It is concluded that the method may be used as a tool for medical investigations and will enable changes to be quantized that cannot be seen by other techniques; practical examples are given. (UK)

17869 DETERMINATION OF TIN AND POISONOUS TRACE ELEMENTS IN CANNED JUICES BY NEUTRON ACTIVATION ANALYSIS. Chisaka, H.; Tanizaki, Y.; Nagatsuka, S. (Tokyo Metropolitan Isotope Research Center). Radioisotopes (Tokyo); 22: No. 5, 247-248(May 1983). (In Japanese).

17870 COMPARATIVE STUDY OF ATOMIC ABSORPTION SPECTROMETRY AND NEUTRON ACTIVATION. Determination of Rubidium in Geochemistry. Roelandts, I.; Guillaume, M. (Univ., Liege). pp 355-362 of Third International Congress of Atomic Absorption and Atomic Fluorescence Spectrometry. Vols. 1 and 2. London; Adam Hilger Ltd. (1973). (In French).

From third international congress of atomic absorption and atomic fluorescence spectrometry; Paris, France (27 Sep 1971).

The application of atomic absorption spectrometry to geochemical analysis presents some drawbacks originating mainly in interference problems. Ionization of alkalies in air-acetylene flame, chemical interferences of Ca and Al must be controlled by buffering the solution with La and K in large excess. Atomization interference and acidity must also be strictly controlled. The limit of detection is about a few ppM. With the neutron activation method with 14 MeV neutrons (Van de Graaff accelerator), on the other hand, there are no interference problems. After solution of the rock the alkalies are selectively fixed on an inorganic filter HAP (hydrated antimony pentoxide) and measurement is performed on the specific peaks 0.22 and 0.46 MeV of ^{84m}Rb from the nuclear reaction: $^{85m}Rb(n,2n)^{84}Rb$. However, the limit of detection is higher than 20 ppM for 1 g of rock. (auth)

17871 CHEMICAL ANALYSIS OF LUNAR SAMPLES. Waenke, H. (Max-Planck-Institut fuer Chemie, Mains). pp 233-250 of Application of Different Spectroscopic Methods to the Solution of Problems in Chemical Analysis. London; Adam Hilger Ltd. (1972).

From 16th international conference on spectroscopy; Heidelberg, Federal Republic of Germany (4 Oct 1971). See CONF-711015--.

The neutron activation methods used in the analysis of lunar materials are described. Major and minor trace elements in lunar fines, breccia, and igneous rocks from Apollo 11, 12, and 14 are tabulated. (DHM)

Chemical and Spectral Procedures

Refer also to abstracts 18197, 18407, 18590, and 20308.

17872 (AEC-tr-7439) DETERMINATION OF THE ISOTOPIC COMPOSITION OF URANIUM AND PLUTONIUM. Koch, L. Translation of Rebecca Greer (New Brunswick Lab., NJ) from Radiochim. Acta; 12: No. 3, 160-162(1969). 6p. Dep. NTIS $4.00.

The simultaneous determination of isotopic concentrations of uranium and plutonium by mass spectrometric isotope dilution analysis is described. The selective behavior of the nitrato complexes on an anion exchanger is used to obtain a uranium and plutonium solution of equal quantities. The difference in ionization efficiency of the two elements makes it possible to determine by mass spectrometry ^{238}Pu in the presence of ^{238}U. (auth)

17873 (CNEA-340) DETERMINATION OF THORIUM BY ISOTOPIC DILUTION. Suner, A. A.; de Batistoni, A. M. L. G.; Botbol, J.; Aprile, R. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1973. 18p. (In Spanish). Dep. NTIS (U. S. Sales Only) $3.00.

A method for determination of Th by isotopic dilution is described. It can be applied for the analysis of low grade ores. The method assures the complete exchange of the tracer added with the ^{234}Th contained in the sample. The analytical method has four steps: (a) attack of the sample with hydrofluoric acid, potassium acid sulfate fusion and sodium carbonate fusion; (b) interference elimination by hydrogen sulfide precipitation; potassium iodate and oxalic acid precipitation, and sorption on ion exchange resin; (c) spectrophotometric measurement of the absorbance of the thorium complex with thorin (sodium salt of 1-(o-arsenophenylazo)-2-naphtol-3,6-disulfonic acid), and (d) radiometric measurement of the chemical yield with a Geiger-Mueller counter. (auth)

17874 (JAERI-M-5097) ISOTOPE DILUTION METHOD FOR THE DETERMINATION OF MERCURY IN AN INDUSTRIAL ELECTROLYTIC CELL. (Japan Atomic Energy Research Inst., Tokyo). Jan 1973. 35p. (In Japanese). NTIS (U. S. Sales Only).

17875 (LA-5232) DETERMINATION OF PLATINUM, IRIDIUM, AND RHODIUM IN URANIUM ALLOYS BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY. Gardner, R. D.; Henicksman, A. L.; Ashley, W. H. (Los Alamos Scientific Lab., N. Mex.). Jul 1973. Contract W-7405-eng-36. 4p. Dep. NTIS $4.00.

Platinum, iridium, and rhodium, at concentrations of 0.01 to 1 wt% in uranium-matrix alloys, are measured by a rapid atomic absorption spectrophotometric method. The alloys are dissolved in hydrochloric and nitric acids (in a sealed tube if iridium is involved), and the noble metals are measured in this solution without separation. The uranium effectively suppresses interelement atomic-absorption effects and at the same time enhances the sensitivities of the individual noble metals. The measurement relative standard deviation generally is no greater than 1% in analyzing alloys containing 0.1 to 1 wt% of noble metals, and no greater than 7% at the 0.01-wt% alloy level. (auth)

17876 (UCRL-74430) MEASUREMENT OF THE MASS SPECTROMETER EFFICIENCY IN THE ISOTOPIC ANALYSIS OF VERY SMALL PLUTONIUM SAMPLES. Carver, R. D.; Dupzyk, R. J. (California Univ., Livermore. Lawrence Livermore Lab.). 26 Jun 1973. 5p. (CONF-730547-2). Dep. NTIS $3.00.

From American Society for mass spectrometry meeting; San Francisco, California, USA (20 May 1973).

A mass spectrometer is described that can be used for the isotopic analysis of environmental samples as small as .006 d/m $^{239,240}Pu$ (30 fg). Soils, plant and animal tissue, water, and ash filters can be analyzed by the method given. (DHM)

17877 DETERMINATION OF MICROQUANTITIES OF TANTALUM BY MEANS OF THE CHEMICOROENTGENOSPECTRAL METHOD. Rossokha, L. A.; Rekhkolainen, G. I. (Inst. of the Chemistry and Tech. of Rare Elements and Mineral Raw Materials, Apatity, USSR). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 8, 1187-1189(Aug 1972).

Translated from Zavod. Lab.; 38: No. 8, 940-941(Aug 1972).

By preliminary extraction enrichment of samples using cyclohexanone as extracting agent, a sensitivity on the order of 0.4 μg can be attained in the chemicoroentgenospectral fluorescent determination of tantalum. (DHM)

17878 PHOTOMETRIC DETERMINATION OF URANIUM IN SEAWATER. Ryabinin, A. I.; Lazareva, E. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 963-964(1972).

Translated from Radiokhimiya; 14: No. 6, 919-921(1972).

A method is described for the photometric determination of uranium in seawater using $Fe(OH)_3$ for the preliminary extraction of uranium and arsenazo III. Uranium is separated from Fe^{3+} by a two-step carbonate leaching; photometry is carried out from 4 to 6M HCl with preliminary reduction of U(VI) to U(IV) using zinc. The mean square error for natural seawater samples is 0.13 μg/liter. (JGB)

17879 SPECTROPHOTOMETRIC DETERMINATION OF LANTHANOIDS WITH METHYLXYLENOL BLUE. Ueda, J. (Kanazawa Univ., Japan). Nippon Kagaku Kaishi; 1973: No. 4, 724-728(Apr 1973). (In Japanese).

A method is described for the spectrophotometric determination of lanthanum, cerium(III), praseodymium, neodymium, samarium,

europium, gadolinium, dysprosium, holmium, erbium, thulium, ytterbium(III), and lutetium with methylxylenol blue (MXB). MXB reacts with lanthanoids to form water-soluble bluish-violet complexes and these aqueous solutions have their absorption maxima at 568 to 576 nm. The pH range over which the coloration is stable varies from pH 9.0 to 9.7 (La) to pH 6.8 to 7.3 (Lu). The sensitivities (Sandell's expression) of the determination for each of lanthanoids are between 0.0037 to 0.0054 $\mu g/cm^2$. On the other hand, lanthanoids react with MXB in the presence of cethyltrimethylammonium bromide (CTMAB) to form water-soluble blue complexes and the absorption maxima of these colored solutions appear within 630 to 650 nm. Maximum color developments are obtained in the pH 7 to 9. The reactions are quite sensitive and the sensitivities according to Sandell's expression are between 0.0017 to 0.0032 $\mu g/cm^2$. Beer's law is obeyed for the complexes of lanthanum, cerium(III), praseodymium, and neodymium at concentration up to 1.6 $\mu g/ml$ and for others up to 20 $\mu g/ml$. As a result of investigation of the composition of praseodymium or gadolinium or lutetium complex, the mole ratio of metal, MXB and CTMAB is estimated to be 1 : 2 : 3. (auth)

17880 UTILIZATION OF HIGH-SENSITIVITY NOBLE GAS MASS SPECTROMETRY IN THE DETECTION OF IODINE-129 AND PLUTONIUM-244. Boulos, M. S. Rolla, MO; Univ. of Missouri (1972). 82p. University Microfilms Order No. 73-17,061.

Thesis (Ph.D.).

Mass spectrometric analysis of the xenon isotopes in natural gas wells demonstrates that radioactive isotopes of element number 53 (I) and element number 94 (Pu) were present at the time of the Earth's formation. Evidence for the now extinct nuclide $^{129}I(t_{\frac{1}{2}} = 17 \times 10^6$ years) was found in CO_2-rich gas while evidence for the now extinct $^{244}Pu(t_{\frac{1}{2}} = 82 \times 10^6$ years) was discovered in other natural gas wells. The amounts of ^{129}I in thyroids was measured by combining neutron activation analysis with noble gas mass spectrometry. The current mammalian thyroid glands contain iodine with an isotopic composition $^{129}I : {}^{127}I \approx 1 \times 10^{-8} : 1.0$. (Diss. Abstr. Int., B)

17881 CHARACTERIZATION OF BORON CARBIDE USING THE ELECTRONIC MICROPROBE. Matteudi, G.; Ruste, J. (Ecole Nationale Superieure de la Metallurgie et de l'Industrie des Mines, Nancy). Rev. Phys. Appl.; 8: No. 1, 27-32(Mar 1973). (In French).

Microprobe studies of boron carbide led to the examination of problems linked with the analysis of light elements such as boron and carbon. The classical ZAF method was employed, the generally used approximations, however, being eliminated. The experimental techniques employed are described together with the results obtained for the boron carbon system. (FR)

17882 CONDITIONS FOR DIFFERENTIATED DETERMINATION OF MANGANESE, CERIUM, AND VANADIUM BY AMPEROSTATIC COULOMETRY WITHOUT THE USE OF AN AUXILIARY REAGENT. Nikolaeva, E. R.; Lakeeva, T. N.; Agasyan, P. K. (Moscow State Univ.). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 8, 1151-1153(Aug 1972).

Translated from Zavod. Lab.; 38: No. 8, 910-913(Aug 1972).

The possibility of using amperostatic coulometry for the separate and joint determination of manganese(VII), cerium(IV), and vanadium(V) without electrochemical generation of the titrant was explored. The method can be of practical interest in cases where the solutions contain high concentrations of inert electrolytes. Data obtained confirm that it is possible to determine the investigated ions coulometrically with sufficient accuracy, reproducibility, and sensitivity ($\sim 10^{-6}$ M). The method is also suitable for the analysis of samples containing iron, which in this case acts as auxiliary reagent. (DHM)

17883 POLAROGRAPHIC DETERMINATION OF MICROGRAM AMOUNTS OF ARSENIC IN Te, Se, S, Sn, AND AMMONIATE-FORMING METALS. Pats, R G.; Zhdanov, S. I.; Semochkina, T. V.; Shuvalova, E. D.; Rudakova, S. V (State Scientific Research Inst. of Nonferrous Metals, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 9, 1329-1334(Sep 1972).

Translated from Zavod. Lab.; 38: No. 9, 1053-1057(Sep 1972).

A method is described for the determination of arsenic based on the peaks in an ac polarogram obtained against a background of hydrochloric acid solution (a hydrochloric acid solution of potassium iodide). The effect of iron (III) on the arsenic peak in polarograms was studied. Methods are given for determining 2×10^{-5}% As in Te, 5×10^{-6}% As in Se, 5×10^{-6}% As in ammoniate-forming metals (Cu, Zn, Ni, Co), and 10^{-4}% As in S or Sn. (DHM)

17884 ULTRAMICRO-SCALE METHOD FOR THE DETERMINATION OF THE URANYL CATION. Wood, G. P. (Univ. of San Andres, La Paz, Bolivia). Analyst; 98: No. 1168, 525-528 (Jul 1973).

A method that requires the use of very simple equipment has been developed whereby the uranyl cation can be determined at the micro-scale and ultramicro-scale levels with high precision. The method involves the use of the catalytic effect shown by the uranyl cation on the photo-decolorization of a naturally occurring carotenoid-type pigment. The interfering effects of several common anions and cations are also discussed. (auth)

17885 SURFACE ANALYSIS OF ION IMPLANTS USING SECONDARY EMISSION MASS SPECTROGRAPHY. Hernandez, R.; Vidal, G.; Lanusse, P.; Slodzian, G. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). Mem. Sci. Rev. Met.; 70: No. 1, 47-51(Jan 1973). (In French).

From Autumn meeting on metallurgy; Paris, France (2 Oct 1972).

The analysis of Th implants in Nb is presented. The method utilized enabled variations in chemical composition to be determined as a function of depth and the presence of contaminations by MO^+ or even MC^+ type ions to be established. The secondary ion emission source is described. (FR)

17886 ISOTOPIC ANALYSIS OF PLUTONIUM BY MASS SPECTROMETRY. Sato, H.; Asakura, Y.; Kagami, K.; Kamata, M. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan). Jap. Anal.; 22: No. 4, 424-431(Apr 1973). (In Japanese).

Results of a study on the amount of plutonium necessary to make an accurate determination of isotopic composition of plutonium by mass spectrometry show that a suitable amount of plutonium is 0.2 μg. The precision of the results was as follows;

Atomic % of plutonium isotope	Precision (relative)
80 ~ 90%	±0.1 ~ ±0.2%
5 ~ 15%	±0.2 ~ ±0.4%
1 ~ 5%	±0.4 ~ ±0.6%
0.1 ~ 1%	±0.6 ~ ±1.0%
smaller than 0.1%	±1 ~ ±5%

The limit of detection of the isotopic abundance is 0.01%. (DHM)

17887 ISOTOPE DILUTION MASS SPECTROMETRY OF POTASSIUM. Murozumi, M.; Nakamura, S. (Muroran Inst. of Tech., Hokkaido, Japan). Jap. Anal.; 22: No. 2, 145-151(Feb 1973). (In Japanese).

Isotope dilution mass-spectrometry can be applied to the determination of minute amounts of potassium in distilled water, deionized water and snow melts from snow strata in Greenland and Antarctica. Sample size required is 10 g. Potassium concentrations are found to be at levels of 0.18 ppB in redistilled water, 0.19 ppB in deionized water, 1 ppB in antarctic snows and 3 ppB in Greenland snows. (DHM)

17888 IMPROVEMENTS IN OR RELATING TO CARBON CONTENT ANALYSIS. Long, G. (to United Kingdom Atomic Energy Authority). British Patent 1,315,303. 2 May 1973. Filed date 13 Jun 1969. 4p.

Reference is made to devices for measuring the C content of liquids and particularly liquid metals, such as Na. The device described comprises an enclosure for insertion into the liquid, the material of which takes up C. On the inner surface of the enclosure is a layer of solid decarburant, and means are provided for measuring the products of decarburizing. The enclosure material may be Fe and the decarburant may comprise FeO. The means for measuring the decarburizing products may comprise means for measuring the static pressure change within the enclosure. CO is removed from the enclosure as it is formed and its quantity determined. Renewal of the CO is by a sweep gas or vacuum system. (UK)

17889 ATOMIC ABSORPTION SPECTROMETRIC DETERMINATION OF MOLYBDENUM IN STEEL. Maruta, T.; Takeuchi, T. (Nagoya Univ., Japan). Nippon Kagaku Kaishi; 1973: No. 3, 518-520(Mar 1973). (In Japanese).

The interference of iron on atomic absorption of molybdenum and its elimination were investigated for a determination of molybdenum in steel using a nitrous oxide–acetylene flame. Iron caused the prominent interference with the molybdenum absorption. The molybdenum absorption was enhanced, it became constant in various flame conditions irrespective of iron concentration, provided that the solution containing molybdenum and iron was heated with hydroxylamine hydrochloride before spraying into the flame. Hydrazine sulfate, sodium sulfite and metallic zinc were tested for the reduction of iron and the constant absorption of molybdenum was given in the fuel-lean flame. In the fuel-rich flame, the molybdenum absorption was slightly decreased by the elevation of iron concentration. The effects of iron on the molybdenum absorption became constant in 0.05 mol/l phosphoric acid solution, but enhancement effect was lower than that of hydroxylamine hydrochloride. (auth)

17890 SPECTROPHOTOMETRIC DETERMINATION OF SMALL AMOUNTS OF CERIUM IN STAINLESS STEEL. Takahari, T.;

Yamamoto, Y.; Nakamura, M. (Nippon Steel Corp., Tokyo). Jap. Anal.; 22: No. 4, 383-389(Apr 1973). (In Japanese).

The determination of 0.005 to 0.1% of cerium in stainless steel with a spectrophotometric method is described. In order to remove the interfering elements and to obtain a higher recovery of cerium(III), electrolysis and coprecipitation method were employed. (DHM)

17891 USE OF N-ACETYLSALICYLOYL-N-PHENYLHYDROXYLAMINE FOR AMPEROMETRIC DETERMINATION OF NIOBIUM(V). Gallai, Z. A.; Polikarpova, N. V.; Sheina, N. M.; Dittrikh, N. V. (Moscow State Univ.). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 9, 1341-1343(Sep 1972).

Translated from Zavod. Lab.; 38: No. 9, 1063-1066(Sep 1972).

N-acetylsalicyloyl-N-phenylhydroxylamine (APHA) can be used in the amperometric determination of Nb(V) using both graphite and dropping mercury electrodes. With a potential of 1.0 V at the graphite electrode good results were obtained at concentrations between 7×10^{-4} and 7×10^{-3} M Nb using 8 to 11.5 M HCl as indifferent electrolytes. Amperometric titration of Nb with APHA solution using a dropping mercury electrode in 10 M HCl at −1.0 V gives a fairly clearly recorded end point and reproducible results. (DHM)

17892 DETERMINATION OF URANIUM IN ALLOYS WITH ZIRCONIUM AND ALUMINUM. Kukisheva, T. N.; Voronkova, A. S.; Zil'bershtein, S. L. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 960-962(1972).

Translated from Radiokhimiya; 14: No. 6, 917-919(1972).

An accelerated exchange method for the determination of uranium in its alloys with zirconium and aluminum, without preliminary removal of uranium and its supplementary reduction, is reported. Titration of the dissolved sample is accomplished using ammonium vandate. The coefficient of variation at a uranium content of about 10% does not exceed 0.7%. Duration of the determination is 20 min. The presence of silicon in the alloys does not interfere with the determination of uranium. (auth)

17893 DETERMINATION OF LANTHANIDES IN ORGANOMETALLIC COMPLEXES BY THE CLOSED OXYGEN FLASK METHOD. Borda, P.; Crease, A. E.; Legzdins, P. (Univ. of British Columbia, Vancouver). Microchem. J.; 18: 172-177 (1973).

A simple and rapid method for the determination of lanthanides in organolanthanide complexes based on the closed oxygen flask method of combustion was developed. Although a number of methods of final determination have proved to be satisfactory, the preferred procedure involves the following steps. The combustion products are absorbed in 1N HNO_3, interfering metal elements are removed if necessary, the pH of the solution is adjusted to 4.8, and the desired lanthanide element is evaluated by a direct potentiometric titration with EDTA. The accuracy of the final results is good, and the method was applied during the analysis of several air- and moisture-sensitive cyclopentadienyl derivatives. (auth)

17894 ACCURACY IN SPECTROPHOTOMETRY AND LUMINESCENCE MEASUREMENTS. Proceedings of the Conference Held at Gaithersburg, Maryland, March 22−24, 1972. Mavrodineanu, R.; Shultz, J. I.; Menis, O. (eds). Washington, DC; National Bureau of Standards (1973). 264p. (NBS-SPEC.PUBL-378; CONF-720351--). GPO $4.85.

The 18 papers presented at the Conference on Accuracy in Spectrophotometry and Luminescence Measurements organized by the Analytical Chemistry Division of the National Bureau of Standards and held from March 22 to 24, 1972 are presented. The problems encountered in accurate spectrophotometry and luminescence measurements of materials are discussed. The status of these competences from the standpoint of basic principles and critical factors involved in the measurements are defined as well as the instrumental conditions which must be fulfilled to assure accurate measurements. Particular attention is given to the selection, production, and use of Standard Reference Materials in spectrophotometry and spectrofluorometry. Problems related to health are also covered in six of the papers, two of which include original contributions to the application of luminescence techniques to specific biochemical problems. (auth)

17895 SPECTROPHOTOMETRIC DETERMINATION OF SILVER IN NUCLEAR PURE URANIUM SAMPLE. Shukla, R. D.; Gokhale, R. V.; Mahajan, L. M.; Jogdeo, S. M. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 11: No. 2, 199-200(Feb 1973).

A method is described for the separation and spectrophotometric determination of silver in nuclear pure uranium samples. Silver is separated from interfering elements by its coprecipitation with p-dimethylaminobenzylidine rhodanine at pH 2.8 to 3. The silver rhodanate precipitate after filtration is dissolved in nitric acid and silver determined spectrophotometrically by p-dimethylaminobenzylidine rhodanine in 0.05N nitric acid at a wavelength of 495 nm. Silver can be determined up to one ppM in nuclear pure uranium sample by this method. (auth)

17896 GAS CHROMATOGRAPHIC MICRODETERMINATION OF IODINE BY DERIVATIZATION WITH KETONES. Hasty, R. A. (Montana State Univ., Bozeman). Mikrochim. Acta; No. 4, 621-624(1973).

Derivatization of iodine with 2-butanone, 2-pentanone, or 3-pentanone yield products which have greater response to electron capture detection and which are extracted more completely than the product of the iodine reaction with propanone. Both these observations support the extension of the gas chromatographic determination of iodine into the ng/ml range. (auth)

17897 CATALYTIC DETERMINATION OF IODINE IN SERUM AT NANOGRAM LEVELS USING THE As(III)/Ce(IV) REACTION. Ke, P. J. (Univ. of Windsor, Ont.); Thibert, R. J.; Walton, R. J.; Soules, D. K. Mikrochim. Acta; No. 4, 569-581(1973).

A catalytic determination of iodine using the As(III)/Ce(IV) reaction was developed. The difference in reaction rate due to catalysis by iodide was measured spectrophotometrically at 310 nm. Optimum reaction conditions were investigated in order to obtain a greater sensitivity in the determination of iodine. The method can be satisfactorily used for samples containing iodine in the 0.4 to 10.0 ng range, with an overall error less than 6%. The method was used for the determination of iodine in serum, and gives results which compare favorably with a present clinical chemistry procedure. (auth)

17898 ANALYSIS OF NUCLEAR RAW MATERIALS. II. Spectrophotometric Determination of Molybdenum in Yellow Cake Samples After Prior Separation by Anion Exchange. Korkisch, J.; Steffan, I. (Univ., Vienna). Mikrochim. Acta; No. 4, 545-557 (1973). (In German).

Two methods are described for the separation of molybdenum from uranium and other metal ions. In one of these procedures, the molybdenum along with the uranium was adsorbed from the 6M hydrochloric acid opening-up solution onto the strongly basic anion exchanger Dowex 1-X8, and then eluted selectively by means of a solution consisting of a mixture of 90 vol.% methanol and 10 vol.% of 6M hydrochloric acid. The second separation method is based on the fact that the decomposition solution is treated with 90 vol.% methanol and then subjected to the anion exchange separation, whereby the elution of the molybdenum is accomplished by means of the same hydrochloric acid−methanol mixture. Following concentration by evaporation of the hydrochloric acid−methanol eluate, the molybdenum is determined spectrophotometrically employing a modified form of the thiocyanate method. This procedure was employed for the determination of the molybdenum in Mexican Cake samples. (auth)

17899 ANALYSIS OF NUCLEAR RAW MATERIALS. I. Titrimetric Determination of Vanadium in Yellow Cake Samples. Korkisch, J.; Steffan, I. (Univ., Vienna). Mikrochim. Acta; No. 4, 533-543(1973). (In German).

A method was developed for the rapid titrimetric determination of vanadium in Mexican Yellow Cake specimens. Following solution of the sample in a mixture of sulfuric and hydrochloric acids, the vanadium is first completely reduced by the addition of iron(II)−ammonium sulfate and subsequently transformed quantitatively into the pentavalent oxidation state by the addition of potassium permanganate. After selective reduction of the excess permanganate by means of sodium nitrite, the excess of the latter reagent was destroyed by means of added urea and the vanadium then titrated in a solution of 5 to 7 vol.% of sulfuric acid containing phosphoric acid. The vanadium was titrated with iron(II)−ammonium sulfate solution using barium diphenylamine sulfonate as indicator. No interferences were caused by the presence of larger amounts of molybdenum and uranium. The results given by this procedure agreed well with those obtained by first separating the vanadium from uranium and molybdenum through ion exchange in 6M hydrochloric acid. These separations were conducted with the strongly basic anion-exchange Dowex 1-X8. (auth)

17900 METHOD OF DETERMINING STABLE ISOTOPES OF NEON IN RADIOACTIVE MINERALS AND NATURAL GASES. Shukolyukov, Yu. A.; Ashkinadze, G. Sh.; Sharif-Zade, V. B. At. Energ. (USSR); 34: No. 6, 461-464(Jun 1973). (In Russian).

A glass vacuum chamber with mercury cut-off and metal bellow valves was used in the extraction of 10^{-9} to 10^{-7} mm^3 of ^{21}Ne and ^{22}Ne from minerals. The mineral samples were melted in a vacuum furnace having a tungsten heater. Chemically active gases were absorbed by means of titanium and calcium getters. H_2O and CO_2 vapors solidified on a trap cooled to −196°C. Xe, Kr, and Ar

were adsorbed by activated charcoal at −196°C. Ne was separated from He (in the proportion 1:10^7) by diffusion of He through a quartz sphere having a diameter of ≈20 mm and wall thickness ≈50 μ (diffusion time 2 to 4 hours). Isotopic analysis of Ne was performed on a modernized MB2302 mass spectrometer: in the chamber there was a titanium-getter pump and a system for dosage of neon by means of mercury valves and calibrated volumes of neon from 10^{-10} to 10^{-6} cm^3. Micro-quantities of neon were determined by the "height of peaks" method, with an error of ±(10 to 15)%. (auth)

17901 THIRD INTERNATIONAL CONGRESS OF ATOMIC ABSORPTION AND ATOMIC FLUORESCENCE SPECTROMETRY. Volumes 1 and 2. Proceedings of the Conference Held in Paris, France, September 27–October 1, 1971. London; Adam Hilger Ltd. (1973). (In several languages).

Sixty nine papers were presented in sections entitled: theory and methodology; apparatus; atomic fluorescence; rocks, soils and minerals; water, agriculture and related subjects; biology; metals; miscellaneous. One paper in the section covering rocks, soils and minerals was in NSA scope, and a separate abstract was prepared for it. (UK)

For an abstract of an individual paper see: 17870.

17902 QUANTITATIVE X-RAY DIFFRACTION ANALYSIS OF TWO PHASED MIXED CARBIDES OF URANIUM AND PLUTONIUM. Lorenzelli, R.; Delaroche, P. (CEN, Fontenay-aux-Roses, France). J. Appl. Crystallogr.; 5: 267-270(1972). (In French).

The proportions of MC and M_2C_3 phases [where M = (U−Pu)] in two-phased mixed carbides (U−Pu)C were measured at various compositions by an x-ray diffraction method. This method is based upon the comparison of integrated intensities of x-ray lines and allows a rapid determination of the amount of sesquicarbide M_2C_3 with a detection limit around 0.5% and a relative accuracy better than 5%. (auth)

17903 ACQUISITION AND REAL TIME PROCESSING OF DIGITAL DATA OBTAINED IN THE ISOTOPIC ANALYSIS OF NITROGEN BY MASS SPECTROMETRY. Guiraud, G.; Pacchiani, L. (CEN de Cadarache, Saint-Paul-les-Durance, France). Analysis; 2: No. 4, 282-286(Apr 1973). (In French).

A simple electronic system was developed to exploit information provided by a mass spectrometer. The system enables the mass and amplitude of peaks detected by the spectrometer to be determined. In the isotopic analysis of nitrogen only the peaks of mass 28(^{14}N,^{14}N) and 29(^{14}N,^{15}N), and possibly 30(^{15}N,^{15}N) are considered. The isotopic ratios are determined from measurements made using a given number of scans. The time gain achieved is important and it is thus possible for a single operator to perform 40 measurements (calculations included) in a day. Although the system was conceived for the analysis of nitrogen, a modification to the data acquisition and processing program can render it suitable for other purposes. (FR)

17904 DETERMINATION OF TELLURIUM IN HIGH-COERCIVITY ALLOYS FOR PERMANENT MAGNETS. Zel'tser, E. Yu.; Kuznetsova, N. N. Tr. Vses. Nauch.-Issled. Inst. Elektromekh.; No. 35, 167-171(1971). (In Russian).

Te, 0.01 to 1.4%, can be determined by spectrophotometric methods in high-coercivity alloys for permanent magnets in the form of I−Te complex at known absorption maxima. The analytical data agreed well with actual values, with a deviation of ±0.002 to 0.01%. (Selenium−Tellurium Abstr.)

17905 SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM(V) WITH OXINE IN AQUEOUS PYRIDINE SOLUTION. Nishida, H. (Iwate Univ., Morioka, Japan). Jap. Anal.; 22: No. 6, 771-773(Jun 1973). (In Japanese).

17906 DOSE-EFFECT CURVE OF THE CHLOROFORM DOSIMETER. Wolschendorf, K. (Univ., Kiel). Atomkernenergie; 21: No. 2, 149-152(1973).

Saturated aqueous chloroform solutions were subjected to x-ray irradiation in the presence of air. The formation of acid was followed by continuous measurement of the electrical conductivity. The dose-effect curve at 200 rad min^{-1} was studied in detail and a mathematical approximation of the curve was made, based on the assumption that the reaction mechanism consists of several reactions in parallel. The yields obtained for some of the so derived parallel reactions are found to be in good agreement with those presented by other authors. (orig.) (GE)

17907 APPLICATION OF DIFFERENT SPECTROSCOPIC METHODS TO THE SOLUTION OF PROBLEMS IN CHEMICAL ANALYSIS. 16th International Conference on Spectroscopy, Heidelberg, Germany, October 4–9, 1971. London; Adam Hilger Ltd. (1972). 306p. (In Several Languages). (CONF-711015--). £5.00.

Eleven papers are included in the plenary lectures and reports section of the 16th International Conference on Spectroscopy. Separate abstracts were prepared for two of the papers. (DHM)

For abstracts of individual papers see: 17871 and 17908.

17908 ELECTRICAL FLAME SPECTROSCOPY. Fassel, V. A. (Iowa State Univ., Ames). pp 63-93 of Application of Different Spectroscopic Methods to the Solution of Problems in Chemical Analysis. London; Adam Hilger Ltd. (1972).

From 16th international conference on spectroscopy; Heidelberg, Federal Republic of Germany (4 Oct 1971). See CONF-711015--.

A review is presented of electrical "flame" spectroscopy that consists of spectroscopic properties and analytical applications of electrically generated "flame-like" plasmas considered from a historical perspective and a comparative assessment of the ultimate potential of the various versions of these plasmas as excitation sources for the determination of trace elements. (DHM)

Radiometric and Radiochemical Procedures

Refer also to abstracts 18200, 18223, 18237, 18302, 18658, 18659, 18916, 19811, and 19976.

17909 (INIS-mf-660/8, pp vp Paper 2) LINE DETERMINATION OF SALT CONCENTRATIONS IN AQUEOUS SOLUTIONS BY NONDISPERSIVE X-RAY FLUORESCENCE ANALYSIS WITH RADIOISOTOPES. Vogg, H. (Kernforschungszentrum, Karlsruhe, Ger.); Jain, S. K.; Herfeld, H. 1972.

From international nuclear industries fair; Basel, Switzerland (16 Oct 1972).

A continuous determination of salt concentrations in aqueous solutions by nondispersive x-ray fluorescence analysis is demonstrated in an example of chromium leather tanning. As exciting source, ^{238}Pu is used. The accuracy of chromium analysis is about ±4%. (INIS)

17910 (ITJ-36) LIQUID SCINTILLATION MEASUREMENTS OF NATURAL TRITIUM IN WATER SAMPLES. Florkowski, T.; Grabczak, J. (Institute of Nuclear Techniques, Krakow (Poland)). Mar 1973. 43p. (In Polish). Dep. NTIS (U.S. Sales Only) $4.25.

A method for determining natural tritium content in water samples for hydrogeological purposes is described. The method is based on electrolytic enrichment and liquid scintillation counting by a commercial Packard spectrometer. An enrichment factor of about 20 can be obtained by the electrolysis system. The accuracy of the determination is ±4% for tritium concentrations above 100 T.U. and ±5 T.U. for lower concentrations. (auth)

17911 (LA-UR-73-941) INCORPORATION OF CARBON-13 INTO FETAL AND MATERNAL PROTEIN AND NUCLEIC ACID DURING VARIOUS INTERVALS OF PREGNANCY IN MICE. Gregg, C.; Smith, D.; Ott, D.; Malanify, J.; McInteer, B.; Mativiyoff, N.; Neubert, D. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 13p. (CONF-730717-1). Dep. NTIS $3.00.

From 9th international congress of biochemistry meeting; Stockholm, Sweden (1 Jul 1973).

The extent to which stable isotope label could be incorporated into various chemical fractions of mouse fetal and maternal tissues under different conditions was investigated. Methods of detecting the stable isotope enrichment achieved were compared. The ^{13}C used in the studies was determined by mass spectrometry or by counting the prompt γ rays emitted following proton bombardment. (MCG)

17912 (ORNL-TM-4249) DESIGN OF A SYSTEM FOR THE NONDESTRUCTIVE ASSAY OF ^{233}U IN WASTE DRUMS. DeCarlo, V. A. (Oak Ridge National Lab., Tenn.). Aug 1973. Contract W-7405-eng-26. 20p. Dep. NTIS $3.00.

A system for the nondestructive assay of waste drums containing ^{233}U has been installed in Bldg. 3019. This system employs two 3 × 3 in. NaI scintillation detectors, and standard counting techniques and analyses of the 2.6-MeV γ radiation emitted by ^{208}Tl. Thallium-208 is a product of the decay of ^{232}U, which is usually present as an impurity in ^{233}U. Results show that the system is capable of determining gram quantities of ^{233}U in a 55-gal rotating drum. Standard deviations of the results are also reported. (auth)

17913 APPROACH TO PROBLEMS ENCOUNTERED IN ELECTRON-PROBE ANALYSIS OF IRRADIATED FUEL SECTIONS. Bramman, J. I.; Yates, G.; Hughes, B. (Dounreay Experimental Reactor Establishment, Scotland). pp 195-199 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Many highly active irradiated mixed oxide fuel samples were successfully examined using an extensively modified AEI SEM 2 electron-probe microanalyzer. The design philosophy underlying the modifications and the specially devised specimen preparation and handling techniques are described. During routine optical microscopic examinations of fuel pin sections, examples of fuel/clad interactions and second-phase segregation are frequently seen. These cannot be investigated in an electron-probe microanalyzer without further preparation to reduce the specimen activity level and therefore it is not possible to examine the surface originally exposed without risk of damage. A reliable method of preparing 200 to 300-μm thick slices was devised and these permit analysis of a section lying within this distance of the original surface. Using such samples, the modified microanalyzer, operating with the original beam current, shows no significant loss of analytical sensitivity or accuracy. The instrument is not in a shielded enclosure, so that analysis of inactive samples and routine maintenance work are unimpeded. Electron-probe examination of selected irradiated fuel samples is now carried out on a semi-routine basis. (auth)

17914 ELECTRON-PROBE MICROANALYSIS OF IRRADIATED FUEL ELEMENTS. Adam, J.; Ewart, F. T. (Atomic Energy Research Establishment, Harwell, Eng.). pp 205-208 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Problems arising from the microanalysis of irradiated fuel pins are twofold; the first concerns the interaction of hard β and γ radiations with the x-ray analyzing system, and the second relates to the radiological protection of the operator. The relative importance of these depends on instrument configuration. (auth)

17915 TECHNIQUES FOR CHEMICAL EVALUATION OF IRRADIATED MATERIALS. Hilton, D. A.; Reed, D.; Robins, I. H. (Central Electricity Generating Board, Berkeley, Eng.). pp 215-218 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

The determination of changes in chemical properties and the redistribution of chemical species in irradiated materials can be achieved by examining the induced radioactivity in the material under specified experimental conditions or after specific preparative techniques. Beta scintillation counting of the ^{85}Kr released from irradiated uranium during post-irradiation oxidation enables changes in ignition temperature to be determined, while microsectioning of Magnox cladding followed by α and γ spectrometry provides diffusion data on actinides and fission products. Characterization of single high-activity particles in reactor coolant debris involves micromanipulative and autoradiographic techniques, with the subsequent chemical and radiochemical determinations being respectively achieved by electron-probe microanalysis and γ spectrometry. A γ-scanning technique used to measure the fission-product concentration profiles in irradiated uranium dioxide is described and brief mention is made of the computer program used to process γ spectra. The relevance of each of these techniques in the assessment of reactor materials performance is discussed. (auth)

17916 DETERMINATION OF POLONIUM IN THE PRESENCE OF LEAD AND BISMUTH. Ampelogova, N. I.; Zakharchuk, G. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 947-948(1972).

Translated from Radiokhimiya; 14: No. 6, 908-909(1972).

A rapid method is reported for the determination of polonium in the presence of bismuth and lead (or one of these elements) without preliminary isolation of polonium. The method is based on the coprecipitation of polonium with bismuth and lead hydroxides. The α activity of the hydroxide precipitate was measured and the Po content determined. (JGB)

17917 SENSITIVITY OF THE ANION EXCHANGE METHOD OF DETERMINING IODINE-131 IN MILK AND WATER IN THE β RADIOMETRY OF THE RESIN ON VARIOUS COUNTERS. Prokof'ev, O. N.; Pokhvalinskaya, G. V. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 949-950(1972).

Translated from Radiokhimiya; 14: No. 6, 909-911(1972).

Studies were made in order to select optimum volumes of the resin and sample (milk, water) to ensure maximum sensitivity for β radiometry of the resin. The coefficients of extraction of ^{131}I on a prepared anion exchange resin for set conditions and rates of passage of the sample were determined. (JGB)

17918 RAPID METHOD FOR MEASUREMENT OF RADIOACTIVE IMPURITIES IN SOLUTIONS OF ^{99m}Tc. Decombaz, M.; Gostely, J. J.; Lerch, P. (Institut d'Electrochimie et Radiochimie, Lausanne, Switzerland). Radiochem. Radioanal. Lett.; 14: No. 4, 287-289(30 Jul 1973). (In French).

A lead covered NaI 3'' × 3'' detector system associated with a γ spectrometer was used to realize the determination of radioactive impurities in ^{99m}Tc solutions for medical use. The speed of the method allows the preventive detection of γ-emitting impurities with energy above 300 keV even when half life is near that of ^{99m}Tc. Sensitivity is better than one ppM for photonic intensity of impurity reported to ^{99m}Tc. (auth)

17919 EXPERIMENTAL RESULTS OF MEASUREMENTS OF THE NITROGEN PERCENTAGE IN WHEAT BY A DIRECT-ABSORPTION METHOD. Kairento, A. L. (Univ. Central Hospital, Helsinki). pp 69-72 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (Ed.). Helsinki; Technical Research Centre of Finland (1973).

From 1st national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121--.

The experimental results of measurements of the nitrogen percentage in wheat using a direct-absorption method are compared with theoretical calculations performed previously. Americium-241 spectral intensity measurements were used in the experimental method. (ERB)

17920 CHOICE OF PRIMARY RADIATION IN X-RAY FLUORESCENCE ANALYSIS VIA L SPECTRA. Kharchenko, A. M.; Afonin, V. P.; Losev, N. F (Geochemical Inst., Novosibirsk, USSR). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 8, 1176-1178 (Aug 1972).

Translated from Zavod. Lab.; 38: No. 8, 929-932(Aug 1972).

Computer calculations were used in determining the Lα secondary intensities for the elements from Z = 47 (Ag) to 92 (U) on excitation by tubes with anodes of Ti, Cr, Fe, Cu, Mo, Pd, W, and Au at voltages of 20, 30, and 40 kV. The elements from 47 (Ag) to 52 (Te) are excited most efficiently by a Ti anode. A Cr anode is effective from 53 (I) to 56 (Ba), and Fe is best for La, Ce, Pr, and Nd. A copper anode can be used for 62 (Sm) to 66 (Dy), while Au or Mo is best for 67 (Ho) to 92 (U). (DHM)

17921 USE OF RADIOACTIVE KRYPTONATE OF SILICA GEL IN CHEMICAL ANALYSIS. I. Determination of Water Vapor in Gases. Naoum, M. M.; Jesenak, V.; Toelgyessy, J.; Lesny, J. (Slovak Technical Univ., Bratislava). Radiochem. Radioanal. Lett.; 14: No. 4, 265-271(30 Jul 1973).

In view of the absorption of moisture by silica gel, the radioactive Kryptonate of silica gel is suggested for the determination of water vapor in gases. Compressed tablets of silica gel kryptonated by the diffusion technique were allowed to absorb different concentrations of moisture in air. The measured residual activities of the tablets after exposure for constant periods were found to depend linearly on the concentration of vapor within the 1 to 3 Vol % range. The absorption process seems to be diffusion-controlled. The concentration of H_2O can be determined by calculation too. (auth)

17922 CHARACTERIZATION OF FALLOUT PARTICLES FROM ELECTRON MICROPROBE X-RAY ANALYSES. Benck, R. F. (Ballistic Research Labs., Aberdeen Proving Ground, MD). Crisco, C.; Runquist, A. W.; Holdsworth, E. F. Health Phys.; 25: No. 2, 188-190(Aug 1973).

This study was carried out to determine the association of the radioactivity of fallout particles with specific elemental distribution within the particle. The 33 samples used for the study originated from five U. S. nuclear detonations. Preparation of the samples for autoradiography and subsequent analysis with an electron microprobe x-ray analyzer is described. Qualitative analysis of the particles is tabulated. In the majority of the fallout particles studied radionuclides were concentrated in specific areas, rich in Fe, relative to the bulk particle. This appeared to result from collision of a molten or semi-molten particle of environmental origin with small radioactive particles. The only fallout particles that were homogeneous in elemental composition and radioactivity distribution were from the Pacific detonations. Low concentration of fireball debris in Pacific detonations could conceivably cause homogeneity by providing a deficiency of condensation nuclei for fission products. (UK)

17923 X-RAY FLUORESCENCE DETERMINATION OF SOME TRACE ELEMENTS IN GEOCHEMICAL STANDARDS. Machacek, V. (Geological Survey, Prague). Cas. Mineral. Geol.; 17: No. 2, 171-182(1972).

Arsenic, Cr, Cu, Mo, Nb, Ni, Pb, Rb, Sn, Sr, U, Y, Zn, and Zr were determined in 36 rock and mineral standards with use of

an internal standard and with poly(vinyl alcohol) as a binder. The lines used, internal standards, x-ray-tube targets, crystals, atmosphere, detector and times of analysis are given; correction factors for coincidences and admixtures in internal standards were applied. Of the results that could be compared with literature values, there was good agreement in most instances. (Anal. Abstr.)

17924 PRINCIPLES AND APPLICATIONS OF ION BEAM TECHNIQUES FOR THE ANALYSIS OF SOLIDS AND THIN FILMS. Chu, W. K. (California Inst. of Tech., Pasadena); Mayer, J. W.; Nicolet, M. A.; Buck, T. M.; Amsel, G.; Eisen, F. Thin Solid Films; 17: No. 1, 1-41(Jul 1973).

A review is presented of how a collimated monoenergetic and monoatomic beam incident on a target provides information on its structure and composition when the energy of the backscattered beam atoms, or of the particles generated by nuclear reactions, is analyzed. Examples are selected with particular emphasis on thin films and Si technology. Three different energy ranges of the incident beam (low energies from 1 to 6 keV, medium energies from 100 to 500 keV, and high energies from 1 to 2 MeV) are defined and discussed separately. In appendices, the spectrum of PtSi is discussed, information on stopping powers is given, and the influence of resonances in scattering cross sections is discussed. 26 figures, 124 references. (auth)

17925 DETERMINATION OF URANIUM AND THORIUM CONCENTRATIONS IN ROCKS USING AN ION ANALYZER. Lancelot, J. R.; Pierre, A. (Univ., Paris). Compt. Rend., Ser. D; 276: No. 19, 2609-2612(9 May 1973). (In French).

Measurements of U and Th concentrations were effected by isotopic dilution using an accurate and rapidly operated apparatus, the CAMECA SMI 300 ion analyzer. The accuracy and reproducibility of the measurements made with a ^{238}U, ^{235}U, ^{232}Th, and ^{230}Th mixture were studied. Measurements were then effected on a standard rock sample. (FR)

Separation Procedures

Refer also to abstracts 18067, 18075, 18234, and 18235.

17926 (CEA-R-4450) DISTRIBUTION OF METALLIC ELEMENT COMPLEXES BETWEEN AN ANION EXCHANGE RESIN AND WATER-METHANOL-HYDROCHLORIC ACID MIXTURES. Rastoix, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1973. 141p. (In French). Dep. NTIS (U. S. Sales Only) $9.25.

Thesis. Submitted to Paris Univ. (France).

The fixing of uranyl(VI) chloride and cadmium(II) complexes on an anion exchange resin was studied for some water-methanol and water-ethanol mixtures. The work carried out involved the successive determination of the chloride ion concentration in the resin as a function of the hydrochloric acid concentration in solution [HCl_s] and of the values of the formation constants for the uranyl(VI) chloride and cadmium chloride complexes in solution. Curves representing the variation of the limiting distribution coefficient as a function of [HCl_s] were established for water-methanol media. These curves and others obtained from published results concerning water-ethanol mixtures were interpreted for a wide range of concentrations of the complexing substance. Studies of the variation of the different factors on which the distribution coefficient depends, with the hydrochloric acid concentration, led to the proposal of an hypothesis on the equilibria between the resin and the solution and on the nature of the predominant complexes in the resin. The complexes are in the form of UO_2Cl_2 and $CdCl_4^{2-}$ when the hydrochloric acid concentration is less than 7 M. For these two elements, the corresponding ion-exchange equilibrium constants were calculated. The values of these constants increase with the percentage of alcohol in solution and can be related to the dielectric constant of the solvent. Using these results, relations enabling to predict the variations of the limiting distribution coefficient for uranyl(VI) and cadmium(II) as a function of [HCl_s] were established. (auth)

17927 EXTRACTION THEORY AND FORM OF THE EXTRACTION COMPLEX FOR THE METALS DYSPROSIUM, HOLMIUM, THULIUM, AND CURIUM IN THE SYNERGISTIC SYSTEM KEROSENE-HTTA-TBP-DILUTE KNO_3. Cox, E. C., Jr.; Davis, M. W. Jr. (Univ. of South Carolina, Columbia). Contract AT(38-1)-525. Separ. Sci.; 8: No. 2, 205-243(1973).

Data were taken for the distribution of HTTA and the metals Dy, Ho, Tm, and Cm in the system kerosene/thenoyltrifluoroacetone (HTTA)-tributylphosphate (TBP)-dilute HNO_3. The theory first proposed by Tournier and Davis [Separ. Sci. 7, 159(1972)] for the HTTA distribution was modified and new values of the equilibrium constants resulting from the theory were determined by a least squares fit of the HTTA distribution data. The new values are K_1 = 14 and K_2 = 3.45. An analysis of the HTTA distribution data indicates that one molecule of TBP associates with one molecule of (HTTA · H_2O) to form a complex. Analysis of distribution data for the metals Dy, Ho, Tm, and Cm using the modified theory indicates that the form of the metal complex is $M^{+3}(TTA)_2(NO_3)(TBP)_2$. A log-log plot of q_o/a as a function of [H^+] under conditions of constant free TBP and HTTA and constant ionic strength indicates an inverse squared effect of [H^+] on the metal distribution ratio, q_o/a. This in turn supports the indication that two (TTA) molecules are associated with the metal complex. No experimental data to verify the presence of (NO_3^-) in the complex have as yet been obtained. (auth)

17928 CHROMATOGRAPHIC SEPARATION OF METAL IONS ON STANNOUS FERROCYANIDE PAPERS. Qureshi, M.; Varshney, K. G.; Khan, F. (Aligarh Muslim Univ., India). Separ. Sci.; 8: No. 2, 279-284(1973).

Ascending paper chromatography of the inorganic metal ions was performed on papers impregnated with the ion exchanger, stannous ferrocyanide, using 19 solvent systems. On the basis of the difference in the migration of the spots on the paper, twenty-three difficult separations were achieved, including Mg-Sr, Ca-Sr, Zr-Th, Ru-Pb, and Zr-La. Arsenic has also been separated from numerous metal ions on these papers. (auth)

17929 EXTRACTION OF RARE EARTH ELEMENTS FROM BASTNASITE BY MINERAL ACIDS. Hirashima, Y.; Shiokawa, J. (Osaka Univ., Suita, Japan). Nippon Kagaku Kaishi; 1973: No. 3, 496-499(Mar 1973). (In Japanese).

Extraction of rare earth elements from bastnasite ($RFCO_3$) by mineral acids was studied. DTA and TGA curves show that the thermal decomposition of bastnasite starts at about 400°C. The decomposition is accompanied with weight loss, and the rate is proportional to $\frac{1}{2}$ power of the concentration of the undecomposed carbonate. According to the x-ray diffraction patterns, the crystal structure is transformed from a hexagonal lattice (a = 7.19 Å, c = 9.81 Å; $RFCO_3$) to a cubic one (a = 5.57 Å; RFO) by thermal decomposition. Corresponding to it, the absorption band (~870 cm^{-1}) of CO_3^{2-} disappears in ir spectra. The burned bastnasite, which had been decomposed by pre-heating, was more easily decomposed by hydrochloric acid than crude bastnasite. Heating of bastnasite at temperature above 500°C for 1.h gave better result in acid extraction of rare earth elements. The yields of acid extraction of rare earth elements. The yields of acid extraction increased by the elevation of reaction temperature and amounts of acids used. Extraction into hydrochloric (12 N), nitric (16 N) and sulfuric (18 N) acid was tested. Nitric acid could be used without any serious trouble. However, some trouble appeared when hydrochloric or sulfuric acid was used; residue was not easily filtered off in the case of HCl extraction, and solid product formed in the treatment interfered with the maintenance of a constant condition in the case of H_2SO_4 extraction. With regard to the yields of rare earth elements, nitric acid extraction gave the best result among the the three mineral acids. (auth)

17930 COMPARATIVE STUDY OF TITANIUM(IV)-BASED EXCHANGERS IN AQUEOUS AND MIXED SOLVENT SYSTEMS. Qureshi, M.; Zehra, N.; Nabi, S. A.; Kumar, V. (Aligarh Muslim Univ., India). Talanta; 20: No. 7, 609-620(Jul 1973).

The antimonate, arsenate, tungstate, molybdate, and selenite of titanium were synthesized. Their composition and chemical and thermal stability were determined. Effects of pH and temperature on ion-exchange capacity were studied. Titanium antimonate was found to be the most stable. The utility of these ion-exchangers for analytical separations was examined by determining the distribution coefficients for 26 metal ions, Mg, Al, Ca, V, Mn, Fe, Co, Ni, Cu, Zn, Ga, Sr, Y, Zr, Cd, In, Ba, La, Ce, Pr, Nd, Sm, Hf, Hg, Pb, Th, in some aqueous, nonaqueous, and mixed solvent systems. Quantitative separations of Hg-Cd, Pb-Cu and Pb-Zn were achieved on titanium tungstate columns, and La-Ba mixtures were separated on a titanium arsenate column. (auth)

17931 SOME STUDIES ON THE TBP EXTRACTION OF ACTINIDES. Patil, S. K.; Ramakrishna, V. V.; Avadhany, G. V. N.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay). J. Inorg. Nucl. Chem.; 35: No. 7, 2537-2545(Jul 1973).

Distribution coefficient data for tetravalent Th, U, Np, and Pu and hexavalent U, Np, and Pu were obtained at different temperatures in the range 10 to 60°C for 3.0M nitric acid and 30% TBP in xylene. From these data the enthalpy changes associated with the extraction of the ions were determined. An attempt was also made to estimate the corresponding free energy and entropy changes. (auth)

17932 o-(2-HYDROXY-5-DODECYLPHENYLAZO)-BENZOIC ACID AND ITS ARSONIC ACID ANALOGUE AS CHELATING LIQUID ION EXCHANGERS. Blasius, E.; Finkenauer, H. J. (Univ. of Saarland, Saarbrucken, Ger.). Talanta; 20: No. 7, 639-645(Jul 1973). (In German).

The syntheses of two new chelating agents o-(2-hydroxy-5-dodecylphenylazo)benzoic acid and the corresponding arsonic acid, are described. Solutions of these in benzene or in chloroform were used as liquid ion-exchangers for the separation of Be and Al, and of Zr and Hf. Both have proved useful for the separation of traces of Fe(III) from solutions of salts. (auth)

17933 REVERSED-PHASE EXTRACTION CHROMATOGRAPHY USING SOLUTIONS OF NITRIC ACID AS ELUANTS. Leene, H. R.; De Vries, G.; Brinkman, U. A. Th. (Free Reformed Univ., Amsterdam). J. Chromatogr.; 80: No. 2, 221-232(13 Jun 1973).

Approximately 40 ions (including Y, Zr, Mo, Ce, Yb, Th, and U) were chromatographed on thin layers of silica gel impregnated with Alamine 336-S, Alamine 336-S oxide, tri-n-octylarsine oxide, tri-n-octylphosphine oxide or tri-n-butyl phosphate, and on non-impregnated silica gel. Solutions of 0.2 to 15 N HNO_3 are used as eluants. R_F spectra and a number of separations are reported. The ions are classified into four groups according to their chromatographic behavior, which is explained on the basis of anion exchange, solvation, hydrolysis and interaction with the support. Data on the extraction of HNO_3 and the co-extraction of water are reported. The behavior of Alamine oxide and tri-n-octylarsine oxide parallels that of high-molecular-weight amines: extraction proceeds through anion exchange. Nitric acid taken up in excess of the stoichiometric amount is mainly present in the organic phase as part of the ion $[O_2NO...HONO_2]^-$. On the other hand, with tri-n-octylphosphine oxide (TOPO) and tri-n-butyl phosphate (TBP), extraction proceeds through solvation; $TOPO \cdot HNO_3$, $TOPO \cdot 2HNO_3$, and $TBP \cdot HNO_3$ are the species present in the organic extracts. (auth)

17934 SEPARATION OF U(VI) FROM CARBONATE SOLUTIONS BY ION FLOTATION. Shakir, K. (Atomic Energy Establishment, Inshas, Egypt). J. Appl. Chem. Biotechnol.; 23: No. 5, 339-347(May 1973).

The ability of uranyl ions to form highly charged anionic complexes with carbonate or bicarbonate anions furnishes the basis of its removal from carbonate media by cationic collectors using the ion flotation technique. In this investigation cetyltrimethylammonium bromide was used as collector. The extent of removal depends on many factors and removals approaching 100% could be achieved under certain controlled conditions. The factors that can affect the flotation process, viz. gas flow rate and concentrations of collector, uranium and carbonate were investigated and the best conditions were selected. (auth)

17935 SORPTION OF CERTAIN RADIOELEMENTS BY AN INORGANIC SORBENT, STANNIC PHOSPHATE. I. Sorption of Zirconium from Nitric Acid Solutions. Krylov, V. N.; Pitalev, V. G.; Trofimov, A. M. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 839-843(1972).

Translated from Radiokhimiya; 14: No. 6, 810-814(1972).

It was found that the ability of tin phosphate to sorb zirconium from aqueous solutions depends on the method of synthesis of the sorbent; however, the difference pertains only to quantitative characteristics. A comparison of the properties of various solvents of tin phosphate permits an establishment of the principal characteristic of this sorbent. The presence of a maximum on the curve of $K_{d_{Zr}} = f(C_{HNO_3})$, at $C_{HNO_3} = 2$ M, showed that primarily monomer forms of zirconium are sorbed by tin phosphate. The formation of nitrate complexes reduces $K_{d_{Zr}}$. Zirconium is sorbed chiefly by the surface layer of tin phosphate. (auth)

17936 COORDINATION CHEMISTRY OF RUTHENIUM IN PROCESSES OF EXTRACTION BY ORGANOPHOSPHORUS COMPOUNDS. III. Extraction of Pentahalogen Complexes of Nitrosoruthenium $[RuNOHal_5]^{2-}$ by Tri-n-alkylphosphine Oxides. Sinitsyn, N. M.; Rovinskii, F. Ya. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 856-860(1972).

Translated from Radiokhimiya; 14: No. 6, 826-831(1972).

The basic principles of the extraction of ruthenium in the form of $[RuNOHal_5]^{2-}$ complexes by trialkylphosphine oxides were studied. It was found that the value of D passes through a maximum in the case of extraction from 4M HCl and increases with replacement of the ligands in the series $Cl^- < Br^- < I^-$. A mechanism of extraction determined by the passage into the organic phase of complexes with composition $(TBPO)_3(H_3O)_2(H_2O)_2[RuNOHal_5]$ is proposed. It is noted that the molecules of the extraction reagent can displace the acidoligand from the internal sphere of the complex after separation of the phases. (auth)

17937 APPLICATION OF COLUMN PARTITION CHROMATOGRAPHY TO THE SEPARATION OF THE VALENCE STATES OF NEPTUNIUM. Ushatskii, V. N.; Preobrazhenskaya, L. D.; Omel'chenko, M. G. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 925-926(1972).

Translated from Radiokhimiya; 14: No. 6, 892-893(1972).

The valence forms of neptunium Np(IV), Np(V), and Np(VI), present in solutions in microconcentrations, were quantitatively separated with the aid of a partitioning column with D2EHPA as the stationary organic phase and a Teflon carrier of the stationary phase. The possibility of using column partition chromatography to determine the content of various forms of neptunium in the presence of microconcentrations of it in solutions of 0.5 to 3 M HNO_3 and 0.5 to 2 M HCl was demonstrated. (auth)

17938 INTERACTION OF TRIOCTYLAMMONIUM SALTS WITH TRIBUTYL PHOSPHATE AND TRIOCTYLPHOSPHINE OXIDE. Dem'yanova, T. A.; Lipovskii, A. A.; Spivakov, B. Ya. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 933-935(1972).

Translated from Radiokhimiya; 14: No. 6, 898-900(1972).

In order to determine the cause of a synergistic effect in mixtures of alkylammonium salts with TBP and trioctylphosphine oxide (TOPO) when used in the extraction of Am(III), Cm(III), Pm(III), Ce(III), Zr, and Th, the ir absorption spectra of solutions of these mixtures were studied. Four trioctylammonium (TOA) salts were studied in CCl_4 and benzene, containing various amounts of TBP and TOPO. Results indicate that TOPO interacts with salts of TOA; this interaction consists of solvation of the cationic portion of the ion pair with the formation of a compound of the type $[R_3NH \cdots O{=}PR_3]^+A^-$. TBP does not solvate the cations in simple salts or in the hexanitrate salt of thorium under the investigated conditions. (JGB)

17939 SORPTION OF URANIUM (IV) AND MOLYBDENUM (IV) BY A POROUS ORGANOPHOSPHORUS CATION EXCHANGE RESIN KF-11 FROM NITRIC ACID SOLUTIONS. Bykhovtsov, V. L.; Kosarev, V. M. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 974-975(1972).

Translated from Radiokhimiya; 14: No. 6, 928-929(1972).

The results of an investigation of the sorption of uranium (VI) and molybdenum (VI) by the cation exchanger KF-11 in a broad range of C_{HNO_3} in aqueous solution are reported. The cation exchange resin in the hydrogen form of class -0.6 + 0.4 mm in the moist state was used in the experiments. The initial concentration of uranium (VI) in aqueous solution was equal to $2.18 \cdot 10^{-3}$ M, that of molybdenum(VI) $1 \cdot 10^{-2}$ M. Sorption was conducted under static conditions at a volume ratio cation exchange: solution of 1:11 for uranium and 1:10 for molybdenum, at the temperature 20 ± 2°C. The time of contact of the cation exchange resin with the solution was equal to 1 h. Results obtained are tabulated. The data indicate that the dependences of the distribution coefficients obtained in the experiments for uranium (VI) and molybdenum (VI) on C_{HNO_3} in the sorption systems (HNO_3 – U (VI) – cation exchange resin KF-11 and HNO_3 – MO(VI) – cation exchange resin KF-11) are identical in nature with the analogous dependences established for these ions in extraction systems. (JGB)

17940 KINETIC STUDY OF ION EXCHANGE ADSORPTIONS OF Co(II) AND Ce(III) AT EXTREMELY LOW CONCENTRATIONS ON CHELATING RESINS. Matsuzuru, H.; Wadachi, Y. (Japan Atomic Energy Research Inst., Tokai). Nippon Kagaku Kaishi; 1973: No. 4, 643-647(Apr 1973). (In Japanese).

The kinetics of ion exchange adsorptions of Co(II) and Ce(III) at extremely low concentrations on the chelating resin, Dowex A-1, was studied by using the limited bath method. The rate of ion exchange adsorption of Co(II) is dependent on the ionic strength of the solution, particle size of the resin, and reaction temperature. At higher ionic strength (0.05 to 0.1), the kinetics is controlled by particle diffusion of Co(II), whereas at lower ionic one (0.001 to 0.01), film diffusion is predominant. The diffusion coefficient of Co(II) for the particle diffusion, calculated by the kinetic equation of Kressman–Kitchner, increases from 5.36×10^{-9} to 8.81×10^{-9} $cm^2 \cdot sec^{-1}$ as the temperature is raised from 10° to 30°C. The apparent activation energy is 4.05 kcal/mol at ionic strength of 0.1. The kinetics of ion exchange adsorption of Ce(III) is independent of the ionic strength and particle size of the resin, and does not obey the kinetic equation for film and particle diffusion. These results support the view that the rate-determining step of this reaction is chelate formation reaction between Ce(III) and iminodiacetic acid, the functional group of the resin. The rate constant is increased from 1.68×10^{-3} to 6.78×10^{-3} sec^{-1} as the temperature is raised from 10° to 30°C, and the apparent activation energy is 13.6 kcal/mol at ionic strength of 0.1. (auth)

17941 CHROMATOGRAPHY OF METALS ON DEAE – CELLULOSE LAYERS IN PHOSPHORIC ACID MEDIA. Kuroda, R.; Kondo, T. (Univ. of Chiba, Japan). J. Chromatogr.; 80: No. 2, 241-245(13 Jun 1973).

The adsorption behavior of forty-eight metals on DEAE–cellulose thin layers was examined in aqueous phosphoric acid media. R_F values are given as a function of phosphoric acid concentration over the range 0.01 to 1.0 M and are compared with those obtained in a similar manner with a crystalline cellulose, Avicel SF. Particularly strong retention on DEAE-cellulose occurred for Mo(VI), W(VI), Re(VII), the platinum group

metals, Au(III) and Bi(III). Weak to moderate retention was also observed for several metals, such as V(V), Fe(III), Se(IV), In(III), the rare earths and U(VI), at lower concentrations of phosphoric acid (<0.1M). (auth)

17942 ADSORPTION BEHAVIOR OF 50 RADIONUCLIDES ON ZINC HEXACYANOFERRATE(II) FROM NITRIC ACID SOLUTION. Valentini, M. T. G.; Maxia, V.; Meloni, S.; Rollier, M. A. (Univ., Pavia, Italy). Gazz. Chim. Ital.; 103: No. 1-2, 205-210(1973).

The adsorption behavior of about 50 ions in nitric medium on zinc hexacyanoferrate(II) (ZFoC), and zinc hexacyanoferrate(III) (ZFiC) was studied by batch equilibration experiments. ZFiC is formed by ZFoC oxidation in nitric acid solutions of molarity greater than 0.1M. Distribution coefficients were measured as a function of nitric acid molarity in the range 0.001 to 8M: in some cases it was also possible to point out the processes responsible for the adsorption. On the basis of the behavior of each element, some radiochemical separations were carried out with chromatographic columns loaded with the two absorbers. The separation of alkali metals, the one of cesium from barium and lanthanum, and the one of iron from cobalt and manganese are presented. (auth)

17943 RADIOCHEMICAL SEPARATION USING TIN DIOXIDE. Brandone, A. (Consiglio Nazionale delle Ricerche, Pavia, Italy); Meloni, S. Girardi, F.; Sabbioni, E. Analusis; 2: No. 4, 300-305 (Apr 1973). (In French).

The behavior of 50 elements in hydrochloric, perchloric, hydrofluoric, and nitric media was studied using a tin dioxide chromatographic column. The tin dioxide used is a commercial type cassiterite having a 99.1% titer and a 0.3% water content. The tests were carried out using radioactive tracers, the concentrations of the solutions lying between 1 and 10 μeq/ml. The results obtained for certain elements (Tm, Ta, and Tc) are presented together with the corresponding elution curves. (FR)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 20627 and 20639.

Chemical and Physicochemical Properties

Refer also to abstracts 18032, 18056, 18627, 18630, 18669, 18750, and 18888.

17944 (CEA-R-4446) PREPARATION OF BORON-ENRICHED $B_{12}H_{12}^{2-}$ IONS FOR USE IN AQUEOUS SOLUTION AS A NEUTRON ABSORBER FOR A HEAVY WATER NUCLEAR REACTOR. Penneroux, J. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jun 1973. 82p. (In French). Dep. NTIS (U.S. Sales Only) $6.25.

The synthesis of the $Li_2B_{12}H_{12}$ salt and of diborane is described. A chemical process was studied for ^{10}B enriched or nonenriched $B_{12}H_{12}^{2-}$ salts. The recovery of secondary products is also described. This recovery enables the equations of the boron reactions to be established, the recycling of these compounds in a reusable chemical form being envisaged. (auth)

17945 (JAERI-M-5053) PHASE DIAGRAMS AND THE DATA FOR LIQUID METALS AND INORGANIC MOLTEN SALTS: ALKALIFLUOROBORATES RBF_4 (R = Li, Na, K, Rb, AND Cs). Ohno, H.; Furukawa, K. (Japan Atomic Energy Research Inst., Tokyo). Nov 1972. 57p. (In Japanese). NTIS (U. S. Sales Only).

Phase diagrams and the following data are given for alkali metal fluoroborates ($LiBF_4$, $NaBF_4$, KBF_4, $RbBF_4$, and $CsBF_4$) and alkali metal fluoroborate-alkali metal fluoride mixtures ($NaBF_4$–NaF, KBF_4–KF, etc.), with reference to Nuclear Science Abstracts up to Vol. 25 (1971): crystal structure, density, dissociation pressure of BF_3 gas, molar volume, viscosity, specific heat, enthalpy, electrical conductivity, Raman and infrared spectra, and solubility. (auth)

17946 (UCLA-34-P-88-34) INTRA- AND INTER-MOLECULAR ENERGY TRANSFER STUDIES. Progress Report, June 1, 1972–May 31, 1973. Nicol, M. F. (California Univ., Los Angeles. Dept. of Chemistry). 15 Jul 1973. Contract AT(04-3)-34. 32p. Dep. NTIS $3.75.

Research is reported in the following areas: (a) dependence of the mechanism and efficiency of energy transfer on the separation between donor and acceptor molecules; (b) displacement of absorption and luminescence bands by the molecular environment; (c) bonding and structure of compressed molecular solids (solid-benzene); (d) chemistry of the organic solid state at high pressures; (e) radiation damage of organic scintillators; and (f) intramolecular energy transfer and photochromism. 34 references. (DLC)

17947 URANIUM–FLUORINE LATTICE VIBRATIONS OF β_1–DIPOTASSIUM URANIUM FLUORIDE. Ohwada, Ken (Division of Chemistry, Japan Atomic Energy Research Institute, Tokai-Mura, Naka-Gun, Ibaraki-Ken, Japan). J. Chem. Phys. 58: No. 10, 4051-4055 (15 May 1973).

The infrared spectrum of β_1–dipotassium uranium fluoride, β_1–K_2UF_6, has been measured in the frequency region from 4000 cm^{-1} down to 30 cm^{-1}. A normal coordinate analysis of the optically active U–F lattice vibrations has been made on the basis of a chain model of infinite $(UF_6)^{2-}_{\infty}$ neglecting the potassium atoms. Some of the observed bands have been assigned to the U–F lattice vibrations on the basis of the results of this analysis. The stretching and repulsion force constants have been obtained and discussed with respect to the uranium–fluorine bond distances. Furthermore, to explain the lower vibration frequencies below 100 cm^{-1}, the interactions between the potassium ions and the infinite $(UF_6)^{2-}_{\infty}$ chains have also been investigated. (auth)

17948 INFRARED SPECTRA OF MATRIX-ISOLATED URANIUM OXIDE SPECIES. I. THE STRETCHING REGION. Gabelnick, S. D.; Reedy, G. T.; Chasanov, M. G. (Chemical Engineering Division, Argonne National Laboratory, Argonne, Illinois 60439). J. Chem. Phys. 58: No. 10, 4468-4475 (15 May 1973).

Stretching modes of several uranium oxide species vaporized from tungsten and iridium Knudsen cells and deposited in argon and krypton matrices have been observed in the 700–900 cm^{-1} region of the infrared. Studies of the spectra as a function of temperature and composition of the condensed urania together with normal coordinate analyses of the spectra of ^{16}O and ^{18}O-containing species have led to the following assignments for the ^{16}O species in argon: $U^{16}O(\nu) = 820.0$ cm^{-1}; $U^{16}O_2(\nu_3) = 776.1$ cm^{-1}, $U^{16}O_2(\nu_1) = 765.4$ cm^{-1} (calc). The spectroscopic evidence strongly indicates a linear geometry for UO_2. Tentative assignments for the stretching modes of UO_3 are also given. (auth)

17949 CHEMICAL APPLICATIONS OF THERMAL NEUTRON SCATTERING. Willis, B. T. M. (ed.). London; Oxford University Press (1973). 312p. £ 9.50.

The book deals with the subject in 12 sections entitled: basic theory of thermal neutron scattering by condensed matter; experimental techniques (general features of neutron beam experiments, instruments for neutron elastic scattering, instruments for neutron inelastic scattering); neutron inelastic scattering and molecular spectroscopy; models for calculating the properties of phonons in molecular crystals; neutron scattering studies of the dynamics of polymer chains; atomic and molecular motion in liquids by thermal neutron scattering; structure and atomic motion in glasses; structure of liquids by neutron scattering; hydrogen bonding, and some results of its study by neutron diffraction; structural studies on nonstoichiometric compounds by the Bragg scattering of thermal neutrons; diffuse scattering and the study of defect solids; neutron diffraction and covalency. Separate abstracts have been prepared for the 2 sections within the subject scope of NSA. (UK)

For abstracts of individual chapters see: 18352 and 19801.

17950 COMPREHENSIVE INORGANIC CHEMISTRY. Volume 1. H, Noble Gases, Group 1A, Group IIA, Group IIIB, C, And Si. Trotman-Dickenson, A. F. (Ed.). Oxford; Pergamon Press (1973). 1487p.

The volume contains fifteen chapters entitled: the element hydrogen, ortho- and para-hydrogen; hydrides; deuterium and tritium; proton, protonic acids and hydrogen bond; the monatomic gases—physical properties and production; the chemistry of krypton, xenon and radon; lithium and its compounds; sodium, potassium, rubidium, cesium, and francium; beryllium; magnesium, calcium, strontium, barium, and radium; boron; aluminum, gallium, indium, and thallium; carbon; an introduction to the organic chemistry of the metallic elements; silicon. (UK)

17951 COMPREHENSIVE INORGANIC CHEMISTRY. Volume 2. Ge, Sn, Pb, Group VB, Group VIB, Group VIIB. Trotman-Dickenson, A. F. (Ed.). Oxford; Pergamon Press (1973). 1615p.

The volume contains eleven chapters, entitled: germanium; tin; lead; nitrogen; phosphorus; arsenic, antimony, and bismuth; oxygen; sulphur; selenium, tellurium, and polonium; fluorine; chlorine, bromine, iodine, and astatine. (UK)

17952 COMPREHENSIVE INORGANIC CHEMISTRY. Volume 4. Lanthanides, Transition Metal Compounds. Trotman-Dickenson, A. F. (Ed.). Oxford; Pergamon Press (1973). 1010p.

The volume contains nine chapters entitled: the lanthanides (lanthanium, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium); carbonyls, cyanides, isocy-

anides and nitrosyls; compounds of the transition elements involving metal–metal bonds; transition metal hydrogen compounds; nonstoichiometric compounds—an introductory essay; tungsten bronzes, vanadium bronzes and related compounds; isopolyanions and heteropolyanions; transition metal chemistry; organo-transition metal compounds and related aspects of homogeneous catalysis. (UK)

17953 COMPREHENSIVE INORGANIC CHEMISTRY. Volume 3. Group IB, Group IIB, Group IIIA, Group IVA, Group VA, Group VIA, Group VIIA, Group VIII. Trotman-Dickenson, A. F. (Ed.). Oxford; Pergamon Press (1973). 1387p.

The volume contains seventeen chapters entitled: copper; silver; gold; Group II B (zinc, cadmium, mercury); scandium, yttrium and lanthanum; titanium; zirconium and hafnium; vanadium; the chemistry of niobium and tantalum; chromium, molybdenum and tungsten; manganese; technetium; rhenium; iron; cobalt; nickel; the second—and third—row elements of group VIII A, B, and C (ruthenium, osmium, rhodium, iridium, palladium, and platinum). (UK)

Isotope Effects

Refer also to abstracts 18025 and 19920.

17954 DIPOLE MOMENT AND HYPERFINE CONSTANTS OF OD $A^2\Sigma^+$ FROM AB INITIO CALCULATIONS. Green, Sheldon (Goddard Institute for Space Studies, 2880 Broadway, New York, New York 10025). J. Chem. Phys. 58: No. 10, 4327-4330 (15 May 1973).

The dipole moment and hyperfine constants of OD (and OH) $A^2\Sigma^+$ have been obtained from ab initio calculations, using self-consistent field and configuration interaction techniques. Special attention has been given to the effects of basis set quality and vibrational motion. For OD $A^2\Sigma^+$ in the ground vibrational level, a value of $\mu = 1.84 \pm 0.06$ D is obtained. This is consistent with a recent measurement by Weinstock and Zare but not with an earlier determination of Scarl and Dalby. (auth)

17955 COMPARISON OF THE ISOTOPE EFFECT FOR DIFFUSION OF SODIUM AND SILVER IN LITHIUM. Mundy, J. N.; McFall, W. D. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. B 7: No. 10, 4363-4370 (15 May 1973).

Separate measurements were made at 150 °C of the simultaneous diffusion of sodium isotopes (^{22}Na and ^{24}Na) and silver isotopes (^{105}Ag and ^{110m}Ag) in lithium. The strength of the isotope effect $f\Delta K$ for sodium is 0.19 ± 0.01 and for silver 0.26 ± 0.01. These values do not correlate well with recent calculations of ΔK determined for impurity diffusion on the basis of the dynamical theory of diffusion. Measurement of the diffusion of silver in lithium is 45% greater than earlier data, and a possible explanation for this discrepancy is given. (auth)

17956 EFFECTS OF LIBRATIONAL ANHARMONICITY IN THE SOLID HYDROGENS. Harris, A. Brooks; Berlinsky, A. John (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104); Meyer, Horst. Phys. Rev. B 7: No. 10, 4720-4733 (15 May 1973).

We compare the results of the recently published anharmonic theory of librons to the best available data on the libron Raman frequencies. This allows us to deduce a refined estimate of the effective value of the intermolecular quadrupolar coupling constant Γ_{eff} for solid H_2 and D_2. The effect on the librons of virtual transitions to the ($J = 3$) rotational state is included with the result that Γ_{eff} is decreased. Our estimate from the optical data is then $\Gamma_{eff} = 0.72 \pm 0.04$ and 0.58 ± 0.03 cm^{-1} for $D_2(x = 1)$ and $H_2(x = 1)$, respectively, at zero pressure, where x denotes the mole fraction of $J = 1$ molecules. We also use the anharmonic density of states to analyze specific heat and $(\partial P/\partial T)_V$ data from which we obtain the average libron energy as a function of x. For $D_2(x = 1)$ the result is $\Gamma_{eff} = 0.70 \pm 0.04$ cm^{-1}. Measurements of the conversion-induced pressure in change H_2 give $\Gamma_{eff} = 0.56 \pm 0.03$ cm^{-1}. Both these determinations are in good agreement with the results from optical data for librons. Furthermore, it is found that there is no significant difference between $\Gamma_{eff}(x = 1)$ and Γ_{eff} determined from pair spectra in H_2 and D_2 with $x \ll 1$. The anharmonic density of states is also used to interpret the infrared absorption sideband spectrum for the creation of a vibron plus libron(s). The part of the spectrum which we attribute to one-libron processes has a width in agreement with this model and as expected there are two-libron processes resulting from cubic anharmonic libron–libron interactions.

Incoherent-neutron-scattering data is also consistent with the anharmonic–libron spectrum. (auth)

17957 TEMPERATURE AND SOLVENT DEPENDENCES OF CHLORINE KINETIC ISOTOPE EFFECTS. Turnquist, C. R. Madison, WI; Univ. of Wisconsin (1972). 179p. University Microfilms Order No. 73-10,745.

Thesis (Ph.D.).

Heavy atom kinetic isotope effects (KIE) offer the opportunity for measurement of subtle transition state structure variation since the potential energy surfaces experienced by an isotopically substituted chemical substrate are identical within the limits of the Born-Oppenheimer approximation. The chlorine leaving group KIE values were specifically examined because these values are uncomplicated by further bonding changes after the bond rupture at the transition state. A study of the chlorine leaving group KIE values for S_N1 or S_N2 reactions of t-butyl chloride, n-butyl chloride and benzyl chloride was undertaken in the range 0° to 60°C. For the solvolysis of t-butyl chloride in methanol, the following values were observed: At 10°C, chlorine KIE = 1.0108_7 while the value at 60°C was 1.0095_3. The slope obtained from a plot of ln(KIE) vs. 1/T for the t-butyl chloride data was 1.77 cm^{-1}. The reaction of n-butyl chloride with thiophenol anion gave the following values: chlorine KIE at 0°C was 1.0096_4; at 60°C the value was 1.0079_4; and the temperature dependent slope from the data was 1.76 cm^{-1}. The reaction of benzyl chloride with thiophenol anion yielded the following data: KIE(0°) = 1.0104_4; KIE(40°) = 1.0090_8; and a temperature dependent slope of 2.00 cm^{-1} while the reaction of benzyl chloride with methoxide anion gave: KIE(20°) = 1.0083_8; KIE(60°) = 1.0072_7; and a temperature dependent slope of 1.87 cm^{-1}. The chlorine KIE value measurements are estimated to be good to ±0.00015 and the determination of the slope, ±0.15 cm^{-1}. The conclusion from this set of examples exhibiting S_N1 and S_N2 behavior is that the rate of change of the temperature dependent factor (TDF) is relatively constant and that the temperature dependence of chlorine KIE values does not differentiate between S_N1 and S_N2 mechanisms nor do changes in the KIE temperature dependence occur for reactions with the same substrate when the transition state structure is varied from product-like to reactant-like. (DHM)

17958 FAR-INFRARED SPECTRA AND BARRIER TO INTERNAL ROTATION OF ETHANETHIOL. Manocha, A. S. (Carnegie Mellon Univ., Pittsburgh); Fateley, W. G.; Shimanouchi, T. J. Phys. Chem.; 77: No. 16, 1977-1981(2 Aug 1973).

Far-infrared spectra of CH_3CH_2SH and CH_3CH_2SD were examined in the vapor phase. SH torsional frequencies corresponding to different rotameters are observed. Doublets are observed for the torsional fundamental vibrations of the light and for the hot bands (i.e., $1 \rightarrow 2$ transition) of the heavy molecule in the gauche conformation. The barrier to internal rotation was calculated using one-dimensional theory and a potential expanded in a Fourier cosine series. Good agreement between the calculated and observed frequencies is obtained with a potential of the form $V(\alpha) = -[43\ (+22)/2](1 - \cos\alpha) - [137\ (\pm 7)/2](1 - \cos 2\alpha) + [474\ (\pm 2)/2](1 - \cos 3\alpha) - [13\ (\pm 1)/2](1 - \cos 6\alpha)$. Methyl torsional frequencies are observed at 247.5, 233.5, and 220.5 cm^{-1} in the light molecule. The barrier to internal rotation around the C–C bond is calculated to be 1359 (±16) cm^{-1}. (auth)

17959 SPECTRA AND STRUCTURE OF PHOSPHORUS–BORON COMPOUNDS. III. Vibrational Studies of Trimethylphosphine–Borane and Trimethylphosphine–Borane-d_3. Odom, J. D.; Hudgens, B. A.; Durig, J. R. (Univ. of South Carolina, Columbia). J. Phys. Chem.; 77: No. 16, 1972-1977(2 Aug 1973).

The infrared (33 to 4000 cm^{-1}) and Raman (0 to 3000 cm^{-1}) spectra of $(CH_3)_3PBH_3$ and $(CH_3)_3PBD_3$ were recorded for the solid state at low temperatures. The spectra were interpreted in detail on the basis of C_{3v} molecular symmetry and P4/nmm space group symmetry. The valence force field model was utilized in calculating the frequencies and potential energy distribution. The calculated potential constants for the adduct are compared to those previously reported for the Lewis base moiety and the differences are shown to be consistent with the structural changes found upon adduct formation. The P–B stretch was found to be extensively mixed with the P–C stretch. The P–B force constant was found to have a value of 2.37 mdyn/Å which seems consistent with the adduct stability. (auth)

17960 HYDROGEN-DEUTERIUM EXCHANGE IN SOME 2,4-DISUBSTITUTED THIOPHENES AND SELENOPHENES. Simonnin, M. P.; Terrier, F. (ENSCP, Paris). Tetrahedron Lett.; No. 29, 2803-2804(Jul 1973).

A report is presented on the structure of stable Meisenheimer adducts formed by the reaction of CH_3O^- ions with various 2-Y-4-Z-disubstituted thiophenes (Y,Z = NO_2, CN). The corresponding 5- and 3-deuterated compounds were investigated. The results indicated a very rapid H/D exchange process at the 5-position, but not at the 3-position. The NMR spectra of the 3-deuterated compounds indicated a structure for the adducts equivalent to that deduced for the selenophenic complex (Paulmier et al, Tetrahedron Letters; 1123 (1973)). The reaction of CH_3O^- ions with the corresponding 2,4-disubstituted selenophenes in CH_3OD also led to H/D exchange at the α position and it is concluded that this exchange process offers a very easy and rapid route to some α-deuterated thiophenes and selenophenes. (UK)

17961 KINETIC ISOTOPE EFFECT OF THE INTRAMOLECULAR HYDROGEN MIGRATION WITHIN 2-OXY-3,6-DI-TERT

BUTYLPHENOXY RADICAL. Prokof'ev, A. I.; Bubnov, N. N.; Solodovnikov, S. P.; Kabachnik, M. I. (Inst. of Elementary Organic Compounds, Moscow). Tetrahedron Lett.; No. 27, 2479-2480 (Jul 1973).

The 2-oxy-3,6-di-tert-butylphenoxy radical was prepared by the photolysis of 3,6-di-tert-butyl-orthoquinone solution in heptane with 2,6-di-tert-butylphenol as hydrogen or deuterium donor. This system is an ideal model for the isotope effect investigation on the simplest reaction of the atom migration between two equivalent states. ESR spectra of these radicals (with OH and OD groups) at temperatures from 3°K to 393°K are presented, and the results discussed. It is concluded that there is good agreement between the experimental and theoretical values of the isotope effect over the whole temperature range. (UK)

17962 THERMODYNAMIC CHARACTERISTICS OF THE HYDRATION OF THE DEUTERIUM ION IN HEAVY WATER SOLUTION. Abrosimov, V. K. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 958-959(1972).

Translated from Radiokhimiya; 14: No. 6, 916-917(1972).

Absolute values for changes in free energies, enthalpies, and entropies during hydration of the deuterium ion in D_2O at 298.15°K are tabulated. The thermodynamic characteristics of the hydration of DCl in D_2O and HCl in H_2O were used as the initial quantities for the calculation. (JGB)

17963 HYDROGEN–DEUTERIUM EXCHANGE IN SOME POLYMER AMIDES. Miller, M. S.; Klotz, I. M. (Northwestern Univ., Evanston, IL). J. Amer. Chem. Soc.; 95: No. 17, 5694-5700(22 Aug 1973).

The kinetics of hydrogen–deuterium exchange was followed for two polymers, poly(N-ethylacrylamide) and poly(N-ethylmethacrylamide), which contain side chain amide groups. Conformational information for these polymers was obtained from viscometry and nuclear magnetic resonance. Infrared spectra showed the presence of hydrogen-bonded and of free amide groups in both polymers. Single first-order exchange processes were observed, and the rate constants, k, obtained from the appearance of OH absorption bands or the disappearance of NH bands, are the same. The polymers exchange more slowly than structurally similar small amides. This behavior is interpretable in terms of steric effects, changes in local dielectric constant in the region of the amide group, and changes in the character of water in the vicinity of the polymers. (auth)

17964 MECHANISM OF CIS-TRANS ISOMERIZATION ABOUT CARBON–CARBON DOUBLE BONDS CATALYZED BY SILVER(I). Johnson, R. A.; Seltzer, S. (Brookhaven National Lab., Upton, NY). J. Amer. Chem. Soc.; 95: No. 17, 5700-5706(22 Aug 1973).

Cis-trans isomerizations of maleylacetone, maleylacetoacetate, and similar compounds are catalyzed by enzymes and by silver ion. The possible relations between the two are discussed. Silver ion catalyzed isomerization of maleylacetone proceeds via a nonradical path and without vinyl proton exchange. The methyl ester and the enol methyl ether of maleylacetone were synthesized and the reactions of silver with these substrates are compared with that for silver and maleylacetone. The methyl ester undergoes rapid silver ion catalyzed isomerization while isomerization of the enol methyl ether is not catalyzed by silver. Solvent isotope effects, pH-rate profiles, and the lack of general acid-base catalysis suggest that a π complex between silver and the monoanion of maleylacetone is formed. The π complex loses a proton in a preequilibrium step and could then undergo intramolecular nucleophilic attack to form a furanone intermediate, which is able to undergo facile rotation about the carbon–carbon bond that is isomerizing. (auth)

17965 DIVALENT CATION AND pH-DEPENDENT PRIMARY ISOTOPE EFFECTS IN THE ENOLASE REACTION. Shen, T. Y. S.; Westhead, E. W. (Univ. of Massachusetts, Amherst). Biochemistry; 12: No. 17, 3333-3337(14 Aug 1973).

2-Phosphoglyceric acid was prepared with deuterium in place of hydrogen on carbon atom 2. The initial rates of dehydration of the normal and deuterated substrates were compared using rabbit muscle enolase and yeast enolase activated by Mg^{2+}, Mn^{2+}, and Co^{2+}. No difference in Michaelis constant was found between the two substrates. With both Mg^{2+}-activated enzymes, however, a primary isotope effect on the maximum velocity of greater than 2 was found at and below the pH optima. On the alkaline side of the pH optima, the isotope effects decrease and the rates for the two substrates approach the same value at higher pH's. The isotope effect for Mn^{2+} yeast enolase also decreases at high pH's, but the isotope effect is smaller than for the Mg^{2+} enzyme throughout the pH range. The Co^{2+} enzyme, in contrast, shows the same rate with both substrates throughout the accessible pH region. It appears that an unprotonated base is required to catalyze removal of the hydrogen from C_2 of the substrate and that at least one other protonated group assists in another step of the reaction. The lower efficiency of the Mn^{2+} and Co^{2+} enzymes appears to result chiefly from a reduction in rate of some step other than proton removal. (auth)

17966 STOICHIOMETRIC NUMBER OF A REACTION AND ITS DETERMINATION FROM KINETIC ISOTOPE EFFECTS. Scholten, J. J. F. (Delft Univ. of Tech., Netherlands). Delft Progr. Rep., Ser. A-F; 1: 26-28(Mar 1973).

The concept stoichiometric number is elucidated and a new method proposed for its determination from kinetic isotope effects. (auth)

17967 RAMAN SPECTRA AND PHASE TRANSITION OF CRYSTALLINE CH_3CN AND CD_3CN. Marzocchi, M. P.; Migliorini, M. G. (Istituto di Chimica Fisica, Florence). Spectrochim. Acta, Part A; 29: No. 8, 1643-1651(Aug 1973).

The Raman spectra of the two crystal forms of CH_3CN and CD_3CN were measured at 80°K. A complete assignment in terms of the molecular motions was obtained for the lattice modes on the basis of the isotopic ratios. The Raman bands, together with ir and x-ray data previously reported, were used to reach a definite conclusion on the structure of both forms. (auth)

17968 UNIMOLECULAR REACTIONS OF CHEMICALLY ACTIVATED 2-FLUOROPROPANE-1,1,1,-d_3, 2-FLUOROBUTANE, AND tert-BUTYL FLUORIDE. Randomization of Internal Energies. Kim, K. C.; Setser, D. W. (Kansas State Univ., Manhattan). J. Phys. Chem.; 77: No. 17, 2021-2030(16 Aug 1973).

Vibrationally excited CH_3CHFCD_3 was produced by cophotolysis of $CH_3CHFCOCH_2CH_3$ and $(CD_3)CO$. The half-quenching pressure for HF and DF elimination was 6.0 torr; the primary intramolecular isotope effect was 1.5. The ratio of two decomposition products, $CH_2=CHCD_3$ and $CD_2=CHCH_3$, was found to be invariant with pressure from 0.17 to 125 torr. All of these results are consistent with the behavior expected of an RRKM molecule for which the internal energy was randomized more rapidly than the time for HF or DF elimination ($\sim 10^{-8}$ sec). Vibrationally excited $CH_3CHFCH_2CH_3$ was formed at ~108 and 88 kcal by (i) methylene insertion into C–H bonds of CH_3CHFCH_3 and (ii) by combination of CH_3CHF and CH_3CH_2 radicals. The half-quenching pressures for HF elimination were 10 and 0.46 torr, respectively. The cis- and trans-butene-2 products were formed in equilibrium proportions. The magnitude of the rate constants and the energy dependence are in accord with the predictions of RRKM theoretical calculations and consistent with the trends observed from previous studies. As a minor product, chemically activated $(CH_3)_3CF$ was produced by CH_2 insertion into the secondary C–H bonds of 2-fluoropropane; the half-quenching pressure for HF elimination was ~160 torr. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstract 17865.

17969 (CNEA-342) PREPARATION OF THYMOL ^{131}I. Sanchez Vera, M.; Bianco de Salas, G. N.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1973. 7p. (In Spanish). Dep. NTIS (U. S. Sales Only) $3.00.

The preparation of thymol ^{131}I using chloramine T as oxidizing agent is described. A radiochemical yield of 100% is obtained. The influence of several variables on the final yield is studied, as well as the stability of the labelled product. (auth)

17970 (CNEA-343) PREPARATION OF BENZOIMIDAZOLE ^{131}I. Correia, R. J.; Bianco de Salas, G. N.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1973. 8p. (In Spanish). Dep. NTIS (U. S. Sales Only) $3.00.

A method for labeling benzoimidazole with ^{131}I is described, using chloramine T as oxidizing agent and incandescent lamp as photochemical catalyst. A radiochemical yield of 40% is achieved. Several variables were studied, such as time of reaction, pH, temperature, etc. Stability of the labeled product was also studied. (auth)

17971 HYDROGEN ISOTOPE FRACTIONATION IN THE REACTION OF WATER VAPOR WITH ALKALI METAL MIRRORS. Bremner, R. O. Davis, CA; Univ. of California (1972). 93p. University Microfilms Order No. 73-16,890.

Thesis (Ph.D.).

A study was made of the hydrogen isotope fractionation observed in the reaction of water vapor with alkali metal mirrors. The fractionation occurs so as to enrich the hydroxide in deuterium and to enrich the evolved hydrogen gas in protium. The extent of this fractionation was determined for the metals Li, Na, K, Rb, and Cs over the entire range from zero to one hundred % deuterium in

the water. The extent of fractionation was observed to be in the order Na < K < Li < Rb ~ Cs. The experimental results were shown to be consistent with a mechanism in which water molecules attach to the metal surface and split into an OH (or OD) and an H (or D). Fractionation occurs at this step because of a primary kinetic isotope effect in the reaction of HOD, which favors breakage of the OH bond. It is further proposed that as the concentration of hydroxide builds up, exchange with water begins to occur which retards the fractionation by converting HOH into HOD and HOD into DOD. These opposing processes, together with atom combination to form hydrogen gas, result in a steady state concentration of atoms on the surface. It is suggested that an activation barrier to surface diffusion exists and that atom combination occurs when those atoms which have sufficient energy to overcome the barrier collide with stationary atoms. A simple mathematical model of the combination process is developed and shown to be consistent with appropriate vibrational frequencies taken from the literature. (Diss. Abstr. Int., B)

17972 NEW METHOD FOR THE TRANSFORMATION OF ^{14}C-4 PROGESTERONE INTO ^{14}C-4 PREGNENOLONE USING 3β TRIMETHYLSILYLOXY-20,20-ETHYLENEDIOXY-3,5-PREGNADIENE. Hoellinger, H.; Nguyen-Hoang-Nam; Pichat, L. (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C; 276: No. 8, 715-717(19 Feb 1973). (In French).

Eniminium perchlorated (X) was used to transform progesterone-4-^{14}C (I) (2mM, 7mCi) into 20,20-ethylenedioxy-4-pregnene-3-one 4-^{14}C (XII) with an almost theoretical yield. The silylation of (XII) with a bis-(trimethylsilyltrifluoroacetamide)-trimethylbromosilane-pyridine mixture quantitatively produces 3β-trimethylsilyloxy-20,20-ethylenedioxy-3,5-pregnadiene-4-^{14}C (XIII); this latter product is stereospecifically reduced by an isopropanol-$LiBH_4$ solution into 3β-hydroxy-20,20-ethylenedioxy-5-pregnene-4-^{14}C (XIV) with an 80% yield. The cleavage of the ethylenedioxy group of (XIV) with oxalic acid leads to the production of pregnenolone-4-^{14}C (IV) with a radioactive yield of 50% in relation to (I) after purification with a silica gel chromatographic column. (FR)

17973 ISOTOPIC EXCHANGE PROCESSES IN HOMOGENEOUS CATALYTIC REACTIONS. 2. H/D Exchange in the Deuteration of Cyclo-Alkenes in the Presence of Tris(triphenylphosphine)rhodium-(I)chloride. Bayerl, B.; Wahren, M.; Graefe, J. (Zentralinstitut fuer Isotopen und Strahlenforschung, Leipzig). Tetrahedron; 29: No. 13, 1837-1842(Jun 1973). (In German).

The homogeneous deuteration of cycloalkenes in benzene solution at 22 ± 1°C under normal pressure using tris(triphenylphosphine)rhodium(I)chloride is reported. In all cases isotopic scrambling accompanies deuteration, the extent of this scrambling depends very much on the ring size. Simultaneously a H/D-exchange takes place in the cycloalkenes. These results are discussed on the basis of a mechanistic scheme containing reversible formation of rhodium-alkyl species. (auth)

17974 PREPARATION OF [^{14}C]-GIBBERELLIC ACID. Hanson, J. R.; Hawker, J. (Univ. of Sussex, Brighton, Eng.). Phytochemistry; 12: No. 5, 1073-1075(May 1973).

A combination of a chemical and a microbiological method is described for the preparation of [^{14}C]-gibberellic acid. (auth)

17975 UTILIZATION OF BORON TRIFLUORIDE COORDINATION COMPOUNDS FOR THE SEPARATION OF OXYGEN AND SULFUR ISOTOPES. Fouassier, M.; Forel, M. T. (Univ., Bordeaux). Compt. Rend., Ser. C; 276: No. 12, 1061-1063(19 Mar 1973). (In French).

The isotopic exchange equilibrium constants of stable isotopes of oxygen and sulfur were calculated from the vibration spectra of boron trifluoride coordination compounds. (FR)

17976 EXCHANGE OF OXYGEN BETWEEN THE URANYL GROUP AND WATER. Nemodruk, A. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 874-877(1972).

Translated from Radiokhimiya; 14: No. 6, 843-847(1972).

The exchange of oxygen between uranyl ions and water was investigated in a 0.24M solution of HCl and in concentrated HCl by direct and reverse methods. Water with an ^{18}O content of 0.9634 at. % was used for the experiments. It was established that exchange in concentrated HCl at room temperature goes to completion within 24 h, whereas it is not detected in a 0.24M solution of HCl. (auth)

17977 BEHAVIOR OF DI- AND TETRAHYDROPORPHYRINS UNDER ALKALINE CONDITIONS. Direct Observation of the Chlorin-Phlorin Equilibrium. Whitlock, H. W.; Oester, M. Y. (Univ. of Wisconsin, Madison). J. Amer. Chem. Soc.; 95: No. 17, 5738-5741(22 Aug 1973).

The title phenomenon was investigated in tert-butoxide-tert-butyl alcohol-d_1 mixtures. A fast nonisomerizing H-D exchange is observed accompanied by a slower chlorin-phlorinide ion equilibration. (auth)

17978 LABELLING OF PROTEINS TO HIGH SPECIFIC RADIOACTIVITIES BY CONJUGATION TO A ^{125}I-CONTAINING ACYLATING AGENT. Bolton, A. E.; Hunter, W. M. (Medical Research Council, Edinburgh, Eng.). Biochem. J.; 133: No. 3, 529-539(Jul 1973).

A method is described for labelling proteins to high specific radioactivities with ^{125}I. The protein is treated with a ^{125}I-labelled acylating agent, iodinated 3-(4-hydroxyphenyl)propionic acid N-hydroxy-succinimide ester, which reacts with free amino groups in the protein molecule to attach the ^{125}I-labelled groups by amide bonds. Three protein hormones were labelled by this method, human growth hormone, human thyroid-stimulating hormone, and human luteinizing hormone. Specific radioactivities of up to 170, 120, and 55 $\mu Ci/\mu g$ respectively were obtained for these hormones. The immunoreactivity of these labelled hormones was investigated by using a radioimmunoassay system specific for each hormone. These preparations were also compared with and found to be equal or superior to labelled hormones prepared by chemical substitution of ^{125}I into tyrosine residues of the proteins by using the chloramine-T-oxidation procedure. With some antisera the immunoreactivity of the antigen was diminished by the introduction of a single I atom into the tyrosyl groups, whereas antigen containing a single ^{125}I-labelled 3-(4-hydroxyphenyl)propionamide group showed the same immunoreactivity as the unmodified antigen. (auth)

17979 RADIOCHEMICAL STUDY OF SELF-DIFFUSION AND ISOTOPE EXCHANGE IN AQUEOUS SOLUTIONS. Part VIII. The Theory of Determining Isotope Exchange by Diaphragm Method (Without Analytical Separation of Components). Gosman, A.; Soldatov, E. A. (Technical Univ., Prague). Z. Phys. Chem. (Leipzig); 252: No. 3-4, 241-248(1973).

A general theory of the diaphragm method of determining isotope exchange in solutions is presented. An analysis of the basic relations is also given. (auth)

Feed Materials Processing

Refer also to abstract 18224.

17980 URANIUM ORE TO URANIUM CONCENTRATES. Techniques and Outlook for the Processing of Uranium Ores. Leger, J. E.; Boutonnet, G. (Compagnie de Produits Chimiques et Electrometallurgiques Pechiney-Ugine Kuhlmann, Paris). Energ. Nucl. (Paris); 15: No. 1, 13-20(Jan 1973). (In French).

The reasons and circumstances behind the development of the uranium metallurgy industry in France are discussed. Two special processes are used in France: the calcium process and paste attack. Chemical, technological, and economic studies carried out since 1960 have helped to determine the most logical connection between the concentrating plants on the mine sites and the fluorination preceding the enrichment. The yellow cake method is only justifiable under special circumstances, while the UF_4 method seems to be an appropriate intermediate stage under all circumstances. Two processes were tested up to the pilot stage for the on site production of UF_4 suitable for conversion into UF_6. (FR)

Radiation Chemistry

Refer also to abstracts 17946, 17968, 18050, 18386, 18458, 19476, 19867, and 20228.

17981 (AEC-tr-7223/11-12) NUKLEONIKA. Translated from Nukleonika; 16: No. 11-12, 513-632(1971). 114p. (TT-70-55104/11-12). Dep. NTIS $7.75.

17982 (AEC-tr-7430, pp 30-36) EVALUATION OF THE QUANTITATIVE YIELDS OF RADIOLYSIS PRODUCTS OF CHOLESTEROL IN CONNECTION WITH THEIR POSSIBLE ROLE IN THE PATHOGENESIS OF RADIATION SICKNESS. Kaznacheev, Yu. S.; Kolomiitseva, I. K. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 13: No. 1, 24-28(1973).

The radiolysis of cholesterol in ethanol, n-hexane, and n-butanol was investigated. It was shown that the radiation chemical yields of the "destruction" of cholesterol and the formation of cholesterol peroxides differ, constituting 0.12 molecule/100 eV and 0.5 molecule/100 eV, respectively, at a cholesterol concentration of $6.5 \cdot 10^{-3}$ M. The yield of the radiation breakdown of cholesterol depends on the concentration, which indicates the contribution of the direct action of radiation. The yield of the radiolytic formation of cholesterol peroxides is unchanged within the investigated concentration range. It was shown by removal of the solvent from the irradiated

samples that peroxides are associated with cholesterol, and their concentration is greater than the cholesterol concentration. (tr-auth)

17983 (COO-3212-10) ANNUAL PROGRESS REPORT, APRIL 1973. Box, H. C. (State Univ. of New York, Buffalo (USA)). Dept. of Physics; Roswell Park Memorial Inst., Buffalo, N. Y. Dept. of Biophysics). 1973. Contract AT(11-1)-3212. 112p. Dep. NTIS $7.75.

Separate abstracts were prepared for seven papers included in the report. An electronic and mechanical design of a cross-coil detection head of an NMR spectrometer that operates at 285 MHz is also included. (DHM)

For abstracts of individual papers see: 17984–17990.

17984 (COO-3212-10, pp vp Paper 1) OBSERVATION OF AN ELECTRON TRANSFER PROCESS. Budzinski, E. E.; Lilga, K. T.; Box, H. C. 1973.

In annual progress report, April 1973.

Electron transfer was observed by ESR spectroscopy in x-irradiated single crystals of partially deuterated glycine hydrochloride. The crystals were irradiated at 4.2°K and the transfer occurs on warming to 77°K. It consists of the movement of electrons between carboxyl groups with the electrons exhibiting greater affinity for protonated carboxyl groups than for deuterated carboxyl groups. A slight perturbation of β-proton hyperfine couplings in carboxyl anion radicals due to substitution of a deuteron for a proton on the carboxyl group was also observed. The shift in coupling, which amounts to a fraction of a MHz, was measured by ENDOR spectroscopy. (auth)

17985 (COO-3212-10, pp vp Paper 2) ESR AND ENDOR STUDIES OF DL SERINE IRRADIATED AT 4.2°K. Lee, J. Y.; Box, H. C. 1973.

In annual progress report, April 1973.

The primary products formed by ionizing radiation in single crystals of DL serine were studied by ESR and ENDOR spectroscopy. The crystals were maintained at 4.2°K during irradiation and measurement. The primary reduction product is formed by the addition of an electron to the carbonyl oxygen of the carboxyl group. The primary oxidation product is a radical resulting from decarboxylation. A third product is a radical formed from serine by removal of hydrogen from the hydroxy group. (auth)

17986 (COO-3212-10, pp vp Paper 3) OXIDATION AND REDUCTION OF BARBITURIC ACID DIHYDRATE BY IONIZING RADIATION AT 4.2°K. Box, H. C.; Budzinski, E. E. 1973.

In annual progress report, April 1973.

The primary oxidation and reduction products produced by ionizing radiation in single crystals of barbituric acid irradiated at 4.2°K were identified from their ESR and ENDOR spectra. The primary reduction product is an anion formed by electron addition. The primary oxidation product is a neutral radical resulting from the loss of hydrogen from an >NH group. (auth)

17987 (COO-3212-10, pp vp Paper 4) PROTON HYPERFINE COUPLING TENSORS IN CONJUGATED RADICALS FROM ENDOR MEASUREMENTS ON SOLIDS: IMIDAZOLE DERIVATIVES. Ngo, F. Q.; Box, H. C. 1973.

In annual progress report, April 1973.

The ENDOR method was used to measure proton hyperfine couplings in the free radicals produced by x-irradiation in single crystals of histidine HCl and acetylhistidine. The radicals are formed by hydrogen addition to the imidazole ring. Spin densities were inferred from the anisotropic components of the hyperfine couplings. The results are compared with spin densities calculated from Huckel theory. (auth)

17988 (COO-3212-10, pp vp Paper 5) ESR AND ENDOR MEASUREMENTS ON GLYCYLGLYCINE HNO_3 X-IRRADIATED AT 4.2°K. Rustgi, S. N.; Box, H. C. 1973.

In annual progress report, April 1973.

ESR and ENDOR spectroscopy were used to observe the effect of ionizing radiation on single crystals of glycylglycine HNO_3 x-irradiated at 4.2°K. The paramagnetic species NO_3^{2-} and NO_2 are formed. The ^{14}N hyperfine and quadrupole coupling tensors were determined from the ENDOR spectra and the g tensors were determined from ESR spectra for both species. A mechanism of NO_2 formation is suggested which involves transfer of a proton to NO_3^{2-} and formation of OH^-. (auth)

17989 (COO-3212-10, pp vp Paper 6) CRYOPROTECTION OF IRRADIATED SPECIMENS. Box, H. C. 1973.

In annual progress report, April 1973.

The question was considered of whether or not the effects of radiation damage can be minimized by maintaining the sample at low temperature (4.2°K) during electron microscopy. Examples are given to show that although low temperature will not prevent ionization of the molecule by high energy electrons much less atomic rearrangement occurs at low temperature. (DHM)

17990 (COO-3212-10, pp vp Paper 7) ESR AND ENDOR STUDIES OF IRRADIATED NUCLEIC ACID CONSTITUENTS. Box, H. C.; Freund, H. G. 1973.

In annual progress report, April 1973.

ENDOR and ESR studies were made of primary oxidation and reduction products produced by ionizing radiation of barbituric acid and thymidine single crystals. (DHM)

17991 (DP-MS-72-68) CURIUM-244 ALPHA RADIOLYSIS OF NITRIC ACID. Oxygen Production from Direct Radiolysis of Nitrate Ions. Bibler, N. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 1973. Contract AT(07-2)-1. 17p. (CONF-730403-4). Dep. NTIS $3.00.

From 165th meeting of the American Chemical Society; Dallas, Texas, USA (8 Apr 1973).

Dissolved ^{244}Cm was used as an α-particle source to study radiolytic evolution of oxygen and hydrogen at atmospheric pressure from aerated nitric acid or $NaNO_3$–0.4 M H_2SO_4 solutions. Dose rates were ~10^{18} eV/ml-min, and evolution rates were linear up to a maximum dose of ~10^{20} eV/ml. G values were dependent on nitrate ion concentration, and results were identical in either nitric acid or $NaNO_3$–0.4 M H_2SO_4 solutions. As nitrate ion concentration increased, $G(H_2)$ decreased and $G(O_2)$ increased. These results agree with published results using ^{210}Po as an α-source, but contradict those with ^{239}Pu as an α-source. Above 2M NO_3^-, $G(O_2)$ increased linearly with the electron fraction of nitrate ion, and it is concluded that oxygen is produced by direct radiolysis of nitrate ions. The 100-eV yield of oxygen from this effect is 2.2, in agreement with that obtained from γ radiolysis. Studies of gas evolution from solutions containing both ^{244}Cm and Pu(IV) showed that Pu(IV) does not affect $G(O_2)$. (auth)

17992 (JAERI-M-4796) AXIAL MIXING OF PARTICLES IN THE AGITATED MOVING-BED REACTOR FOR THE GAS-PHASE GRAFT COPOLYMERIZATION OF BUTADIENE TO POLYVINYL CHLORIDE POWDER. Yoshida, K.; Suzuki, K.; Omichi, H.; Sekiguchi, A.; Yamashita, Y. (Japan Atomic Energy Research Inst., Tokyo). Apr 1972. 31p. (In Japanese). NTIS (U. S. Sales Only).

A moving bed reactor with an agitator is used in a pilot plant for the graft-copolymerization of butadiene to poly(vinyl chloride) (PVC) by irradiation with ^{60}Co γ rays. The agitation is for removal of the heat of reaction. This type of reactor, however, tends to have a wide distribution of residence time due to the agitation. The consequences are a lack of uniformity in the grafting ratio and a lowering of mechanical quality of the modified PVC. (auth)

17993 (NSRDS-NBS-42) SELECTED SPECIFIC RATES OF REACTIONS OF THE SOLVATED ELECTRON IN ALCOHOLS. Watson, E. Jr.; Roy, S. (Notre Dame Univ., Ind. Radiation Lab.). Aug 1972. 16p. (COO-38-784). GPO $0.30.

Solvated electrons are generated in alcohols by radiolysis, photolysis, reaction with sodium, etc. Rates of reactions of e_s^- with solvent and solute molecules, ions, and transients, in alcohol solutions, were compiled. Arrhenius parameters are tabulated for some reactions. (auth)

17994 (ORO-3106-48) RADIATION CHEMISTRY OF HYDROCARBON AND ALKYL HALIDE SYSTEMS. Progress Report, August 1, 1972–July 31, 1973. Hanrahan, R. J. (Florida Univ., Gainesville). 1973. Contract AT(40-1)-3106. 19p. Dep. NTIS $3.00.

Research progress is reported in the following areas: gas-phase radiolysis of C_2F_6–C_2H_6 mixtures; gas-phase radiolysis of ethyl bromide; rare-gas-sensitized reactions of fluorocarbon systems; radiation chemistry and mass spectrometry of CF_3I and C_2F_5I; radiation chemistry and hot atom chemistry of tetrafluorocyclobutane. (DHM)

17995 RADIO-INDUCED POLYMERIZATION OF 3-(α-FURYL)PROPENAL AND ITS DERIVATIVES IN SOLUTION. Yamakita, H.; Hayakawa, K. (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku; 21: No. 8, 225-229(Aug 1972). (In Japanese).

It has been shown that 3-(α-furyl) propenal and its derivatives can be polymerized in some organic solvents by γ-ray irradiation, though the bulk polymerization of these monomers does not occur with γ-ray irradiation in the solid state nor in the liquid state above the melting points. The polymers formed in chlorinated hydrocarbon solutions were black or dark brown, and have long conjugated double bonds and crosslinked structure which were formed by the opening of furan rings. It was concluded that the polymerization in chlorinated hydrocarbon solutions was initiated by a certain irradiation product from the solvents. The polymers formed in dioxane, diethyl ketone, and isobutyl alcohol were red

or yellow, and the mechanism of the polymerization seems to be different from that in chlorinated hydrocarbon solutions. In addition, thermogravimetric analyses of the polymers were carried out in air, and thermal properties of the polymers were discussed. (auth)

17996 RADIOINDUCED ADDITION REACTION OF SOME HYDROSILANES TO POLYFLUOROCYCLOBUTENES AND -CYCLOPENTENES. Ueda, T.; Muramatsu, H.; Inukai, K. (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku; 21: No. 10, 282-290(Oct 1972). (In Japanese).

The γ-radioinduced addition reactions of several silanes, $HSiCl_2C_6H_5$ (Ph), $HSiCl_3$ (Cl), $HSiCl_2CH_3$ (Me), $HSiCl(CH_3)_2$ (Me_2), and $HSi(C_2H_5)_3$ (Et_3) to polyfluorocycloalkenes, $(CF_2)_n CCl = CH$ [n = 2 [1], n = 3 [2]] and $(CF_2)_n CCl = CCl$ [n = 2 [3], n = 3 [4]] were studied. While the 2,2-dihydropolyhalocycloalkylsilanes were obtained together with the corresponding 1:1 adducts in the addition of silanes to [1] or [2], the addition to [3] or [4] gave both the dehydrochlorinated 1:1 adducts and the 1:2 adducts. The apparent reactivities of the polyfluorocycloalkenes and the silanes were found to be in the following orders, respectively: [1] > [2] > [3] > [4]; (Et_3) ≫ (Me_2) ≧ (Me) > (Cl) ≫ (Ph). The direction of attack of the silyl radical on the unsymmetrical cycloalkenes and the reaction mechanisms were discussed. (auth)

17997 RADIOLUMINESCENCE OF ORGANIC MEDIA. 3. Experimental Investigation of Aromatic Liquid Solutions. Heisel, F.; Fuchs, C.; Voltz, R. (Centre National de la Recherche Scientifique, Strasbourg). J. Phys. (Paris); 34: No. 2, 203-209 (Feb 1973). (In French).

Studies of the scintillation decay of aromatic liquid solution exposed to beta radiation demonstrated that the delayed component of the decay is due to an interaction between two triplet states of the solute excited by energy capture from the solvent. The Stern–Volmer constant of the reaction transferring energy from the triplet states of the solvent to the solute was estimated to be $350M^{-1}$ for benzene and toluene solutions. The lifetime of the lowest triplet state of the solvent is less than 20 nanoseconds. Finally the radius of the high activation density cylindrical zones in which the bimolecular annihilation of the triplet states took place was evaluated to be about 40A. (FR)

17998 DEHYDRATION EFFECT ON RADIOINDUCED POLYMERIZATION OF ACRYLONITRILE. Iiyama, S.; Abe, S.; Namba, K. (Tokyo Univ.). Kobunski Kagaku; No. 335, 134-139(Mar 1973). (In Japanese).

In a study of radioinduced bulk polymerization of acrylonitrile, the dependence on dose rate, the effect of temperature and the copolymerization with methyl methacrylate were investigated in a system dried strictly by means of BaO (dry system) comparing with those in a normal system dried by CaH_2 (wet system). In the dose rate dependence of the polymerization rate was 0.60 to 0.66, the activation energy was 2.4 kcal/mol, $r_{AN} = 0.12 \sim 0.19$ and $r_{MMA} = 1.1$ to 1.5. These results present evidence for radical mechanism, while in the dry system at –78.5°C the rate was proportional to the first power of dose rate and the composition curve agreed with that of anionic catalyzed copolymerization, moreover the rate had a minimum value of about –35°C, which indicates that the anionic mechanism contributes to the polymerization. In the dry system at 0°C the results showed that the polymerization proceeded by both radical and anionic mechanism. (auth)

17999 ISOTHERMAL DECAY OF TRAPPED ELECTRONS IN IRRADIATED 2-METHYLTETRAHYDROFURAN GLASS. Ichikawa, T.; Yoshida, H.; Hayashi, K. (Hokkaido Univ., Sapporo). Bull. Chem. Soc. Jap.; 46: No. 3, 812-817(Mar 1973).

The isothermal decay of the electron trapped in γ-irradiated 2-methyltetrahydrofuran glass was studied by electron spin resonance measurements at 92 to 95°K. Shape of the decay curves was found to be independent not only of radiation dose but also of temperature if they were plotted on the time scale in unit of half-life at each temperature studied. Although the decay follows neither a first order nor a second order reaction, the activation energy is able to be determined uniquely to be 0.8 eV. These results indicate that the mobilization of trapped electron is caused by repeated sequences of detrap-retrap due to thermal distortion or destruction of traps and that the evolution of decay is determined by the initial distribution of the electron-cation separation. On the basis of Nernst–Einstein assumption, the normalized distribution of the separation distance is numerically obtained and found to be close to a Gaussian function, though the absolute value of distance is unable to be determined because of the lack of knowledge of diffusion coefficient for the migration of electron in the glass. The effect of partial photobleaching of the trapped electron on the isothermal decay for the rest of electron was also studied and found to be the same as that of partial thermal bleaching. (auth)

18000 RADIATION CHEMISTRY. Hughes, G. Oxford; Clarendon Press (1973). 89p.

The subject is dealt with in sections: development of radiation chemistry (historical introduction, radiation sources); interaction of radiation with matter (energy loss of γ-rays, energy loss of electrons, energy loss of other charged particles, effect of LET, time scale of events, comparison with photochemistry, dosimetry); ions and electrons (radiolysis of gases, radiolysis of liquids, radiolysis of solids); excited states (production and decay of excited states, evidence for the existence of excited states, chemical reactions of excited states, excited states in the radiolysis of gases); free radicals (production and detection of free radicals in irradiated systems, free radicals in the radiolysis of water, measurement of radical yields); studies of selected systems (water, dinitrogen monoxide, oxygen, hydrocarbons, polymerization of monomers, irradiation of polymers, graft copolymerization); applications of radiation chemistry (general considerations, production of ethyl bromide, production of gammexane, production of detergents, nitrogen fixation, polymerization, sterilization, food preservation, radiobiology). (UK)

18001 PHOTOCHEMICAL OXIDATION OF URANIUM(III) IONS IN AQUEOUS SOLUTIONS. Nakamura, S.; Fukutomi, H. (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 116, 53-56(Mar 1973).

The photochemical oxidation of U(III) ion in acidic aqueous solution was investigated in the presence and absence of some specific scavengers. The quantum yield of U(IV) ion was independent of the absorbed light intensity, but depended significantly on the wavenumber of the irradiated light and added salt concentration. Acetone, added as an electron scavenger, decreased the quantum yield of hydrogen, whereas the quantum yield of U(IV) ion was unchanged. Isopropyl alcohol, added as a specific scavenger of hydrogen radical, had little effect on the quantum yields of U(IV) ion and hydrogen up to 0.5 M. U(IV) ion showed the retardation effect. All these results are well explained by assuming the hydrated electron as the primary product of photolysis. (auth)

18002 SOLVATION TIME OF THE ELECTRON IN LIQUID ALCOHOLS AND WATER AT ROOM TEMPERATURE. Gilles, L.; Aldrich, J. E.; Hunt, J. W. (Univ. of Toronto). Nature (London) Phys. Sci.; 243: No. 126, 70-72(28 May 1973).

It is stated that the solvation time of the electron in water and various alcohols is estimated as about 10 ps, or faster. A study was made to obtain information in the range 210 to 277°K in order to obtain good values for the solvation times and activation energies of the process from extrapolation of the Arrhenius plot to room temperature. A stroboscopic pulse radiolysis system was used with a flow system to permit cooling of the solutions to 190°K. Spectra were measured from 350 to 750 nm and reaction kinetics studied from 18 to 350 ps at chosen wavelengths. In all the alcohols studied the solvated electron exhibited an absorption maximum near 600 nm and the solvation times were measured at that wavelength. Typical formation curves for solvated electron in methanol are shown. A clear distinction was apparent for curves at 296 and 217°K; at the lower temperature the electron took more than 200 ps to become fully solvated, whereas at room temperature solvation took place within the rise time of the equipment. Absorption signals were also observed at 1000 nm in the cold alcohols, probably arising from a partially solvated electron. Rate constants are shown tabulated for the solvation of methyl, ethyl and n-propyl alcohols at various temperatures. It is generally believed that alcohols show three distinct dielectric relaxation regions. The observed activation energies for the solvation process are about 5 k cal. Activation energies, half-lives of solvation at room temperature, and dielectric relaxation times at constant charge for the lowest frequency region are also shown tabulated. To estimate the solvation time in water a 3 M $CaCl_2$ solution was used. The absorption maximum shifted from 680 nm at room temperature to 620 nm at 236°K, and the kinetics appeared similar to those of methanol at room temperature. Assuming that the activation energies for the solvation process in alcohols and water are similar, the solvation time in the aqueous solution at room temperature is about 0.2 ps, agreeing well with the value expected for the relaxation time at constant charge of an electron in water. (UK)

18003 γ RADIOLYSIS AND PULSE RADIOLYSIS OF CARBON DISULFIDE IN AQUEOUS SOLUTION. Roebke, W.; Schoeneshoefer, M.; Henglein, A. (Hahn-Meitner Institut fuer Kernforschung, Berlin). Z. Naturforsch., 28b: No. 1/2, 12-22(1973). (In German).

A polymer $(CHS_2)n$ and sulfate are formed in the γ-irradiation of deaerated aqueous carbon disulfide solutions; the G values are 3.6 and 0.41. Pulse radiolytic experiments show that CS_2

reacts with e^-_{aq} and OH in a diffusion controlled manner. The first product of the reaction with OH is the radical SC(OH)S. The absorption spectra of the radicals SC(OH)S and $SC(O^-)S$, those of the radical anion SCS^- (formed by reaction of CS_2 both with e^-_{aq} and H), and the spectrum of SC(H)S radical were measured. SC(OH)S disappears by second order with $2k = 1.6 \times 10^9$ at pH = 6, SCS^- by second order with $2k = 6.4 \times 10^9$ and SC(H)S radical by second order with $2k = 7.4 \times 10^9$ $M^{-1}s^{-1}$. (GE)

18004 ESR STUDIES OF ELECTRON-IRRADIATED $K_3Ir^{III}(CN)_6$ IN KCl SINGLE CRYSTALS. II. Strong Quadrupole Effects on the Hyperfine Structure in $Ir_{II}(CN)_5$ Species. Vugman, N. V.; Caride, A. O.; Danon, J. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 19: No. 9, 249-264(1973).

The effects of a large quadrupolar interaction in the $Ir^{II}(CN)_5$ molecule in a KCl lattice are analyzed using a MAGNSPEC computer program. Some empirical rules are given to help in the interpretation of this kind of spectra. g and A deduced ligand field formulas for a d^5_z ground state are used to calculate the unpaired electron density on the metal. The hyperfine constants are determined to be positive leading to a positive value for the core polarization constant χ, indicating a mixture of 6s wave function in the unpaired electron molecular orbital. The ESR data indicate the presence of two nonequivalent sites for the $Ir^{II}(CN)_5$ molecule in KCl, differing only by the orientation of the principal axes of the quadrupolar interaction. A possible influence of the vacancies created by charge compensation on the existence of these two sites is discussed. The ratio between the nuclear quadrupole moments for the iridium isotopes is determined to be ^{193}Q: $^{191}Q = 0.91 \pm 0.03$. (auth)

18005 VAPOR-PHASE GRAFT-COPOLYMERIZATION OF METHYL METHACRYLATE ON POLYPROPYLENE FIBERS BY A PREIRRADIATION TECHNIQUE. Kawase, K.; Hayakawa, K. (Government Industrial Research Inst., Nagoya, Japan). Nippon Kagaku Kaishi; 1973: No. 4, 827-831(Apr 1973). (In Japanese).

The vapor-phase graft-copolymerization of methyl methacrylate onto polypropylene fibers was studied by a preirradiation technique and the weight increase during the reaction was followed by a spring balance method. The grafting reaction was suppressed with increasing irradiation temperature. The rate of weight increase of fibers due to the grafting reaction became larger with increasing vapor pressure of monomer and preirradiation dose. The rate of grafting reaction decreased with increasing grafting time in general, but the acceleration in rate was observed with decreasing grafting temperature. The grafted fibers contained almost no occluded homopolymers. The grafting reaction process was well explained by taking into account the increase in sorption caused by the increase in the extent of grafting. The DSC measurement on the stepwise-annealed grafted fibers showed the effect of grafted branch on the recrystallization. (auth)

18006 ESR STUDY OF γ-IRRADIATED AMMONIA–SILICA GEL SYSTEM. Nagai, S. (Japan Atomic Energy Research Inst., Neyagawa, Japan). Bull. Chem. Soc. Jap.; 46: No. 4, 1144-1148(Apr 1973).

Ammonia–silica gel system was γ-irradiated at –196°C. ESR spectrum observed from samples with low ammonia content showed a marked linewidth anomaly in the hf lines at –196°C and changed with temperature reversibly. The free radical responsible for the spectrum was assigned to NH_2 radical which undergoes a preferential rotation about an axis perpendicular to the radical plane at low temperatures and a substantially free rotation above –90°C. (auth)

18007 RADIOLYSIS OF METHANE. Formation of Acetylene. Rebbert, R. E.; Ausloos, P. (National Bureau of Standards, Washington, DC). J. Res. Nat. Bur. Stand.; 77A: No. 1, 109-114 (1973).

The ^{60}Co-γ radiolysis (at 200 to 2000 torr) and the pulse radiolysis (100 to 760 torr) of methane were investigated with the specific purpose of elucidating the mode of formation of acetylene. The following two reactions account for the formation of acetylene in the pulse radiolysis: $C_2H_5^+ + e \rightarrow C_2H_2 + H_2 + H$ (I); $C(^1S \text{ or } ^1D) + CH_4 \rightarrow C_2H_2 + H_2$ (II). Addition of SF_6 as an electron scavenger elimnates reaction I as a source of acetylene, but increases the yield of ethylene through the occurrence of a reaction such as: $C_2H_5^+ + SF_6^- \rightarrow C_2H_2 + HF + SF_5$. In the low dose rate ^{60}Co-γ radiolysis of CH_4–NO mixtures, reaction II is the only mode for formation of acetylene. The $C(^1S \text{ or } ^1D)$ atoms which undergo reaction II are formed in the γ radiolysis and pulse radiolysis, as well as in the 10 and 11.6 to 11.8 eV photolyses, through the dissociation process: $CH_4^+ \rightarrow C + 2H_2$. In the γ radiolysis, the $C_2H_5^+$ ion apparently is intercepted by accumulated products before undergoing homogeneous neutralization process 1. In the 16.7 to 16.8 and 21.2 eV photolyses, evidence is presented that the ions do not undergo homogeneous neutralization. (auth)

18008 PULSE RADIOLYSIS STUDY OF OPTICAL ABSORPTION AND KINETIC PROPERTIES OF DITHIOTHREITOL FREE RADICAL. Chan, P. C.; Bielski, B. H. J. (State Univ. of New York, Buffalo). J. Amer. Chem. Soc.; 95: No. 17, 5504-5508 (22 Aug 1973).

The absorption spectrum of the dithiothreitol free radical was determined in N_2O-saturated aqueous solution (pH 2 to 10) by pulse radiolysis. Variation in molar extinction with pH suggests that the radical can exist in an ionized form I or as a neutral species IV with a pK of 5.5. At pH 8.3, variation of dithiothreitol from 0.1 to 10 mM did not affect the formation nor the disappearance of the radicals. The radicals decay by second-order kinetics throughout the entire pH range. Product analyses by thin-layer chromatography and spectrophotometry indicate that the radicals disproportionate to the oxidized and reduced forms of dithiothreitol. A mechanism is proposed which accounts for the observed acid-catalyzed decay. The radical is oxidized by molecular oxygen at a rate $k = (1.37 \pm 0.15) \times 10^9$ M^{-1} sec^{-1}. (auth)

18009 REACTION OF 3-CYCLOHEXENYL RADICAL WITH NUCLEOPHILES. Myers, D. Y.; Stroebel, G. G.; Ortiz de Montellano, B. R.; Gardner, P. D. (Univ. of Utah, Salt Lake City). J. Amer. Chem. Soc.; 95: No. 17, 5832-5833(22 Aug 1973).

Results of a study of the 3-cyclohexenyl radical are presented which suggest that stability in the radical ion intermediate formed in the reaction of radicals with nucleophiles may not be a requirement and that the coupling of radicals with nucleophiles may be a general reaction. The 3-cyclohexenyl radical was generated by irradiation of cyclohexene or by reduction of 1,3-cyclohexadiene by sodium in ammonia. (DHM)

18010 γ-RADIOLYSIS OF N-HEXANE AND 2,2,4-TRIMETHYLPENTANE AT 77°K IN THE PRESENCE OF TRIPHENYLAMINE. Kroh, J.; Piekarska, J.; Karolczak, S. (Technical Univ., Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 21: No. 4, 285-287(May 1973).

The yields of stabilized radicals in the γ-irradiated title compounds were investigated by ESR technique. The preliminary results of these experiments show that the chemical structure of hydrocarbon affects the mechanism of ionic processes in solid state. (auth)

18011 RADIOINDUCED HETEROGENEOUS POLYMERIZATION. 1. Kinetic Study of Bulk Polymerization of Acrylonitrile. Wada, T.; Watanabe, T.; Takehisa, M. (Japan Atomic Energy Research Inst., Takasaki, Japan). Polym. J.; 4: No. 2, 136-142 (Feb 1973).

The radioinduced bulk polymerization of acrylonitrile at 20°C was studied kinetically. The polymerization proceeded with precipitation of polymer from the liquid monomer and reached a steady state after an initial acceleration period. The dose rate exponent of the rate of polymerization at steady state was about 0.9. On the basis of the kinetic treatment of the polymerization which contained both first- and second-order terminations for the concentration of propagating radical, the rate constant of each elementary reaction was found to be: $k_1 = 2.90 \times 10^{-11}$, $k_p = 2.40$, $k_{tr} = 1.48 \times 10^{-4}$, $k_{t1} = 6.33 \times 10^{-4}$, $k_{t2} = 2.27 \times 10^2$. (auth)

18012 IONIC REACTIONS DURING THE RADIOLYSIS OF LIQUID N-HEXANE AND 2,2,4-TRIMETHYLPENTANE. Kroh, J.; Piekarska, J.; Karolczak, S. (Technical Univ., Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 21: No. 4, 279-283(May 1973).

The γ-radiolysis of the title compounds in the presence of C_2H_5OH labeled with tritium in OH group was investigated. For both hydrocarbons straight lines were obtained, if G(HT) is plotted against the square root of ethanol concentration. The yields of free ions were found from the intercept values to be 0.12 for n-hexane and 0.22 for isooctane. The values of the reactivity coefficient α_s for hexane and isooctane were found to be 0.90 and 0.83 M-1, respectively. The influence of SF_6 on the $G(H_2)$ and $G(CH_4)$ for isooctane solutions was also investigated. The mechanism of ionic processes was proposed. (auth)

18013 RADIOLYSIS OF ANTHRACENE ON METALLIC SURFACES. Doroshenko, V. N.; Chervetsova, I. N.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 18: No. 4, 659-661(Apr 1973). (In Russian).

Energy exchange between phases in the system metal-dielectric was studied by means of evaluating the radiation-chemical transformations in anthracene (from 1 nm to several μ in thickness) on the surface of Al, Ni, and Au. Irradiation of the anthracene films used a ^{60}Co source at 25 to 30°C. A decrease in the film thickness caused a decrease in the radiation-chemical change in the anthracene, the extent of the change being practically independent of the nature of the metal. (KSW).

18014 ELECTRON SPIN RESONANCE IN X-IRRADIATED β-ALANINE. Lyons, R. B.; Close, D. M.; Anderson, R. S. (Clark Univ., Worcester, MA). Chem. Phys. Lett.; 20: No. 5, 442-443 (1 Jul 1973).

Electron spin resonance spectra of x-irradiated powder and single crystal samples of β-alanine do not exhibit any change following several recrystallizations. This negative finding is contrary to a published report. (auth)

18015 RADIOLYSIS OF XENON TRIOXIDE IN AQUEOUS SOLUTION. The $XeO_3 + H_2O_2$ Thermal Reaction. Haissinsky, M.; Heitz, C. (Inst. du Radium, Paris). J. Chim. Phys.; 70: No. 5, 733-737(May 1973). (In French).

The γ radiolysis of XeO_3 in aerated and deaerated aqueous solutions was studied. The effects of pH and radiation intensity were examined. The $H_2O_2 + XeO_3$ reaction was studied at the same pH value. A mechanism explaining the experimental observations is proposed. (FR)

18016 RADIOLYSIS OF AQUEOUS SOLUTIONS WITH STRONGLY IONIZING RADIATIONS. Effect of the $^{10}B(n,\alpha)^7Li$ Nuclear Reaction on the Oxidation by Radiolysis of Fe(II) in the Presence of Cu(II) and on the Formation of H_2O_2 in Formic Acid Solutions. Sigli, P. (CEN, Fontenay-aux-Roses, France); Pucheault, J. J. Chim. Phys.; 70: No. 5, 717-721(May 1973). (In French).

The oxidation yield of Fe(II)(10^{-3}M) in the presence of Cu(II) (10^{-3}M) subjected to the recoil radiation of the $^{10}B(n,\alpha)^7Li$ reaction is $G(Fe\ III)_{Cu} = 2.16 \pm 0.03$ mole/100 eV. The H_2O_2 formation yield in dilute formic acid solutions is $G_1(H_2O_2)_{HCOOH} = 1.18 \pm 0.05$ mole/100 eV. This yield varies with the HCOOH concentration. This variation is quantitatively interpreted in terms of the radical and molecular yields and the participation of intratract reactions. Comparisons of the values obtained with previously obtained results for other systems enabled the yield $G = 0.14 \pm 0.04$ to be calculated for the $OH + H_2O_2 \rightarrow H_2O + H_2O$ intratract reaction. The origin of intratract reactions is discussed and a hypothesis is put forward on the role of secondary electrons (delta rays). (FR)

18017 GAMMA RADIOLYSIS OF WATER AND SOME AQUEOUS SOLUTIONS UNDER N_2 GAS BUBBLING. Koike, M.; Tachikawa, E.; Hashimoto, H.; Ohkubo, T. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 4, 234-241 (Apr 1973).

The γ radiolysis of water subjected to gas bubbling was studied using a specially designed gas-loop. During the irradiation, N_2 gas bubbled from the bottom of the irradiation vessel. As the N_2 gas feed rate was raised, the apparent $G(H_2)$ value increased in keeping therewith, from 5×10^{-3} to 0.26. However in the presence of a sufficient amount of O_2 or H_2O_2, $G(H_2)$ was raised almost to the level of the molecular yield. With reasonable assumptions, it could be concluded that 3 to 5×10^{-6} mole/l of H_2O_2 was sufficient to reduce the back reaction of molecular products to less than 10% under the present experimental conditions. It was also found that the $G(H_2)$ value increased with CH_3OH concentration roughly in proportion to $\log(CH_3OH)$, and reached 3.1 with 0.1 mole/l CH_3OH. (auth)

18018 ELECTRON SPIN RESONANCE STUDY OF PHOTOINDUCED CHANGES OF THE RADICALS PRODUCED IN SOLID METHYL ISOCYANATE IRRADIATED WITH GAMMA RAYS. Fujiwara, M.; Hirai, H. Bull. Chem. Soc. Jap.; 46: No. 3, 701-706(Mar 1973).

Free radicals in the γ-irradiated solid of methyl isocyanate at −196°C were studied by electron spin resonance (ESR) at −196 to −100°C. An oriented solid of methyl isocyanate was prepared by solidification of methyl isocyanate around an aluminum rod under cooling. The original radical and trapped electron produced by γ irradiation were recorded at −196°C in the dark. The original radical produced in the oriented solid gave a resonance pattern consisting of a triplet of triplets and was assigned to $\cdot CH_2NCO$ radical. This was converted completely into a new radical on irradiation with visible light for 90 min. The new resonance pattern consists of a triplet of triplets whose nitrogen and proton splitting constants are 20.0 and 87.4 gauss, respectively. The nitrogen hyperfine splitting was anisotropic and the proton splitting constant agreed with that of methylene imino radical ($H_2C = N\cdot$). The new radical was assigned to methylene imino radical. The resonance pattern of $\cdot CH_2NCO$ radical was restored when the temperature was raised up to −120°C. The mutual conversion between the two radicals by visible light and heat was concluded to be a decomposition of $\cdot CH_2NCO$ into $H_2C = N\cdot$ and CO, and a recombination of these two moieties. (auth)

18019 PULSE RADIOLYSIS STUDY OF THE DIRECT EFFECT ON SULFURIC ACID. Lesigne, B. (CEN de Saclay, Gif sur Yvette, France); Ferradini, C.; Pucheault, J. J. Phys. Chem.; 77: No. 17, 2156-2158(16 Aug 1973).

The radical SO_4^- (or HSO_4) produced by the direct effect of radiation on sulfuric acid was observed in aqueous 0.4, 2, and 4 M sulfuric acid in yields given by $G(SO_4^-) = 4.3f(H_2SO_4)$, where $f(H_2SO_4)$ is the electron fraction of sulfuric acid present. A reaction scheme is proposed to explain the disappearance of SO_4^-. (auth)

18020 HYDROGEN ATOM ABSTRACTION BY METHYL RADICALS IN 3-METHYLPENTANE GLASS AT 77°K. Sprague, E. D. (Max-Planck-Institut fuer Kohlenforschung, Mulheim, Ger.). J. Phys. Chem.; 77: No. 17, 2066-2070(16 Aug 1973).

Using ESR techniques, the thermal decay of methyl radicals in glassy 3-methylpentane at 77°K was reexamined. The methyl radicals were produced by γ irradiation of samples containing small amounts of methyl iodide. In contrast to earlier reports, it has been found that the concentration of 3-methylpentyl radicals, also produced during irradiation, does not remain constant as the methyl radicals decay. Kinetic and stoichiometric analysis of this behavior demonstrates clearly that, at 77°K, most methyl radicals decay by abstracting hydrogen atoms from matrix molecules, producing additional 3-methylpentyl radicals. The earlier assumption that hydrogen atom abstraction would occur too slowly to play a significant role at such temperatures is therefore incorrect in this case. (auth)

Radiochemistry and Nuclear Chemistry

Refer also to abstract 17981.

Hot-Atom Chemistry

18021 SCAVENGER EFFECTS IN THE RECOIL TRITIUM REACTIONS OF CYCLOHEXENE. Fee, D. C.; Markowitz, S. S. (Univ. of California, Berkeley). J. Inorg. Nucl. Chem.; 35: No. 7, 2153-2161(Jul 1973).

The comparative efficiency of H_2S, butadiene-d_6, O_2, and SO_2 as radical scavengers was determined in the T + cyclohexene gas phase system. The T was produced by recoil in the $^3He(n,p)T$ reaction. Direct tritium substitution on cyclohexene yields cyclohexene-t which may undergo unimolecular decomposition to produce butadiene-t. In unscavenged samples butadiene-t is selectively depleted by reactions with H atoms produced by radiolysis. Neither SO_2 nor H_2S is sufficiently reactive with H atoms to protect butadiene-t from such depletion. The "hot" butadiene-t yield can only be determined by means of O_2 or butadiene-d_6 scavenging. All products except butadiene-t exhibit normal behavior with O_2, SO_2 or H_2S scavenging. (auth)

18022 CHEMISTRY OF RECOIL TRITIUM ATOMS. Part 4. Reactions with Olefins in the Presence of Helium. Johnston, A. J.; Urch, D. S. (North East London Polytechnic). J. Chem. Soc., Faraday Trans., I; 69: No. 7, 1186-1194(1973).

The reactions of recoil tritium atoms with ethylene, propylene, isobutene and buta-1,3-diene in the presence of oxygen scavenger and helium moderator are described. The decomposition reactions of excited radicals formed by "hot" tritium atom to the double bond are discussed; it is estimated that the probability of C—C to C—H rupture is about 17 : 1. However, when the yields of products from radicals that can decompose easily only by C—C rupture are compared with those from radicals that can only break C—H bonds the ratio is 1.4 : 1. The increase in the ratio, yield of labelled parent/yield of labelled hydrogen, for small olefins by comparison with the corresponding alkane, is rationalized as partly due to certain excited radical decomposition reactions and partly due to the interaction of the double bond with the orbitals of the recoiling tritium atom and of the impacted C—H, causing a reduction in the activation energy for the displacement reaction. Small yields of some minor labelled products are indifferent to moderator concentration; it is thought they are formed by radiation induced decomposition reactions. (auth)

18023 CHEMISTRY OF RECOIL TRITIUM ATOMS. Part 3. Reactions with but-2-ene in the Presence of Helium, Oxygen, or Nitrogen. Johnston, A. J.; Urch, D. S. (North East London Polytechnic). J. Chem. Soc., Faraday Trans., I; 69: No. 7, 1173-1194(1973).

The effect of adding varying amounts of helium, oxygen, and nitrogen to the reaction of recoil tritium atoms with trans-but-2-ene is studied and the results analyzed by the Estrup Wolfgang method. Despite the uncertainties attendant upon the use of rare gas moderators to determine the relative energies of tritium atoms that produce particular species it is concluded that the energy range for HT formation is broader than, and straddles, the labelling range. It is shown that some recently labelled trans-but-2-ene molecules decompose at low pressure, probably by isomerization. To explain the enhanced yield of labelled propylene in the presence of nitrogen

it is proposed that $[N_2T\cdot]$ is formed which can act as a "carrier" for "hot" tritium atoms. (auth)

18024 ESTIMATION OF THERMAL YIELDS IN THE REACTION WITH METHANES OF ^{80}Br ACTIVATED BY THE (n,γ) PROCESS. Saeki, M.; Tachikawa, E. (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap.; 46: No. 3, 839-844(Mar 1973).

The Estrup–Wolfgang Kinetic theory was applied to the results obtained from the reactions of ^{80}Br activated by the (n,γ) process with two methanes, CH_4 and CD_4. With suitable assumptions, the most probable kinetic parameters, l's and α's were obtained. The thermal yields of the products were estimated as a function of the m.f. of the Kr moderator as the differences between the yields predicted by the kinetic theory with these kinetic parameters and those experimentally obtained. The thermal $CH_3{}^{80}Br$ and $CD_3{}^{80}Br$ yields are strongly affected by the m.f. of Kr in such a way that they are not important in the range from zero to around 0.7 m.f. of Kr, but become significant over 0.7 m.f. of Kr. On the other hand, the thermal $CH_2{}^{80}BrBr$ and $CD_2{}^{80}BrBr$ yields are much less sensitive to the m.f. of Kr and are almost constant at 0.5% over the whole moderator range of Kr. (auth)

18025 REACTIONS OF BROMINE AND CHLORINE ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ISOMERIC TRANSITION IN GASEOUS AND CONDENSED HALOMETHANES. Helton, R. W. Lincoln, NE; Univ. of Nebraska (1972). 137p. University Microfilms Order No. 73-15,365.

Thesis (Ph.D.).

The three bromine isotopes activated by radiative neutron capture, ^{80}Br, ^{80m}Br, and $^{82}Br + {}^{82m}Br$, reacted to different extents in the gaseous CH_3F system. In systems using helium or organic moderators, extrapolation to zero mole fraction moderator (20 Torr Br_2) gave organic yields of 7.0%, 10.0%, and 6.0%, for ^{80}Br, ^{80m}Br, and $^{82}Br + {}^{82m}Br$, respectively. The isotopic difference was less in the gaseous CH_3Cl system, and extremely small, or non-existent, within experimental error, in the gaseous CH_3Br system. A pressure effect in the CH_3F system appeared to exist, for all isotopes, from 50 to 200 Torr. Between 200 and 800 Torr, the reactions were essentially pressure independent. When reactions of the bromine isotope in CH_3F and CD_3F were compared, a definite target molecule isotope effect was found, the CD_3F system giving much lower organic yields. The organic yields at zero mole fraction Br_2 in CH_3F were 8.5%, 10.0%, and 7.5%, while those in CD_3F were 5.5%, 7.2%, and 4.7%, for ^{80}Br, ^{80m}Br, and $^{82}Br + {}^{82m}Br$, respectively. In the gas to condensed phase transition study of the reactions of bromine and chlorine isotopes activated by radiative neutron capture and isomeric transition, it was found that organic yields rose sharply toward higher densities, after remaining essentially constant near the middle regions of the curves. The constant organic yield plateau was attributed to collisional stabilization of translationally excited products, and the subsequent rise, to caging reactions, involving radicals and/or ions produced by the hot atom in its deexcitation process. The importance of the hot atom isotope effect appeared to diminish as the density was increased. Only two organic products were observed in each case: the halogen replacement product and the hydrogen replacement product, the halogen replacement product always being predominant over the other. The reactions of ^{82}Br activated by isomeric transition gave lower yields than those activated by radiative neutron capture in gaseous systems, but higher yields in high-density condensed systems, with the cross-over coming in the vicinity of the critical density region. This means that reactions involving excess kinetic energy are most important at low densities, and reactions involving radicals and ions are, naturally, most important at high densities. (Diss. Abstr. Int., B)

18026 STEADY STATE THEORY OF HOT ATOM REACTIONS. Keizer, Joel (Chemistry Department, University of California, Davis, California 95616). J. Chem. Phys. 58: No. 10, 4524-4535 (15 May 1973).

A simple steady state theory of hot atom reactions is developed based on the Boltzmann equation. The solution to this equation is approximated by a local Maxwell distribution involving the temperature of the hot atoms and steady state distributions are calculated by determining steady values of the hot atom temperature. General considerations imply the existence of steady state distributions with temperatures just below the ambient temperature and a simple model calculation indicates that very reactive systems should have steady or quasisteady states at temperatures much higher than ambient. An application of the theory to a photochemical reaction is shown to be compatible with more extensive computer calculations. If a hot atom distribution becomes steady, it is shown that the loss of hot atoms can be described by a pseudo-first-order rate equation with a rate constant differing from the equilibrium rate constant only by the appearance of the steady state temperature. (auth)

18027 REACTIONS OF RECOIL IODINE FORMED BY THE $^{123}Xe \rightarrow {}^{123}I$ SYSTEM WITH SIMPLE HYDROCARBONS. II. Pressure Studies on the Methane and Ethane Systems. Loberg, M. D.; Krohn, K. A.; Welch, M. J. (Washington Univ., St. Louis). J. Amer. Chem. Soc.; 95: No. 17, 5496-5503(22 Aug 1973).

Recoil iodine species produced by the system $^{128}Xe \rightarrow {}^{123}I$ are reacted with methane and ethane, both with and without additives being present, over the density range 10^{-4} to 0.5 g/cc. Qualitatively, major differences are observed between the behavior of methane and ethane. In methane the yield of organic products drops from ≃50 to ≃10%, while in ethane the yield increases over the same density range. The effects observed in the lower density region (10^{-4} to ≃10^{-1} g/cc) are interpreted in terms of an ion-molecule mechanism previously developed by us to explain the methane system at 1 atm. The trends observed at the higher densities are explained by the auto-radiation hypothesis model. (auth)

Properties of Radioactive Materials

Refer also to abstracts 17918, 17931, 17937, 17950, 17969, 17970, 17976, 18199, 18200, and 19902.

18028 (LIB/Trans-503) STUDY OF TRANSPLUTONIUM ELEMENT HYDROLYSIS. II. Hydrolysis of Americium(III) in the Presence of Ions with Positive and Negative Hydration Energy. Korotkin, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Jun 1973. Translation of JINR-P6-6403. 8p. Dep. NTIS (U. S. Sales Only) $3.00.

The hydrolysis of Am(III) ions in HNO_3 and $HClO_4$ solutions at $\mu = 0.1$ to 1 in the range pH = 1 to 11 was studied. Various effects of ions with positive and negative energy on the hydrolysis process are shown. (auth)

18029 (LIB/Trans-504) STUDY OF TRANSURANIUM ELEMENT HYDROLYSIS. III. Americium and Curium Hydrolysis in Solutions of Pure Nitric Acid. Korotkin, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Jun 1973. Translation of JINR-P6-6404. 5p. Dep. NTIS (U. S. Sales Only) $3.00.

The mechanism of Am and Cm hydrolysis in pure HNO_3 up to pH ≤ 5.5 was studied. Insertion of Li^+ and NH_4^+ ions into HNO_3 at pH = ≤2 suppresses the hydrolysis and shifts the equilibrium to the production of the nitrate complexes. At low pH(≳4) the same operation produces the reverse action. (auth)

18030 (NIIAR-76) COMPLEXING OF AMERICIUM, CURIUM, AND PROMETHIUM TERVALENT IONS WITH PHOSPHONOACETIC ACID. Elesin, A. A.; Zaitsev, A. A.; Kazakova, S. S.; Yakovlev, G. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 14p. (In Russian). INIS.

The dissociation constants of phosphonoacetic acid were determined at an ionic strength of 0.2: $pK_1 = 1.14$, $pK_2 = 7.31$. An ion exchange method was used with the KU-2 cation exchange resin, to investigate the complexing of the trivalent ions of Am, Cu, and Pm. In the range of concentration of phosphonoacetic acid from 10^{-3} to 10^{-1}, and pH of 2 to 4, complexes having the type formulas $M(H_2A)^{2+}$, $M(HA)^+$, and $M(HA)_2^-$ were established for Am, Cu, and Pm. (tr-auth)

18031 (RCN-186) INVESTIGATIONS ON URANYL CHLORIDE, ITS HYDRATES, AND BASIC SALTS. Prins, G. (Reactor Centrum Nederland, Petten). May 1973. 122p. Dep. NTIS (U. S. Sales Only) $8.25.

The preparation and an investigation of various physico-chemical properties of uranyl chloride, its hydrates, and one of its basic salts are described. The methods for the synthesis of UO_2Cl_2, $UO_2Cl_2 \cdot H_2O$, and $UO_2Cl_2 \cdot 3H_2O$ are critically reviewed and the main methods were carefully checked. In order to obtain more information on phase relationships in the uranyl chloride–water system, the system UO_3–HCl–H_2O at 25°C was investigated. Five solubility regions were found with the corresponding solid phases $UO_2Cl_2 \cdot 3H_2O$, $UO_2(OH)Cl \cdot 2H_2O$, $2UO_3 \cdot HCl \cdot 4H_2O$, $4UO_3 \cdot HCl \cdot 8H_2O$, and $UO_3 \cdot 2H_2O$. Vibrational spectra of UO_2Cl_2, its hydrates, $UO_2(OH)Cl \cdot 2H_2O$, $UO_3 \cdot 2H_2O$, and four other uranyl compounds were obtained. The interpretation of these spectra was restricted to a discussion of the stretching frequencies of the uranyl group. The thermal stability of UO_2Cl_2, $UO_2Cl_2 \cdot H_2O$ and $UO_2(OH)Cl \cdot 2H_2O$ was investigated. Anhydrous UO_2Cl_2 decomposes on heating into UO_2 via the intermediate oxychloride $(UO_2)_2Cl_3$. The heats of formation of UO_2Cl_2, its hydrates, and $UO_3(OH)Cl \cdot 2H_2O$ were determined calorimetrically by means of the heats of solution in hydrochloric acid. The heat content of anhydrous UO_2Cl was measured in the temperature range 119 to 423°C, using a diphenyl ether drop calorimeter. The equilibrium constant of the reaction: $U_3O_8(s) + 3Cl_2(g) \rightleftharpoons 3UO_2Cl_2(g) + O_2(g)$ was measured in the temperature range 862 to 1054°C, using the entrainment method. Finally, a summary of the thermodynamic data for anhydrous UO_2Cl_2 is given. (auth)

18032 (RFP-Trans-137) MASS SPECTROSCOPIC INVESTIGATIONS ON TRI- AND TETRACYCLOPENTADIENYL METAL COMPLEXES. Mueller, J. Translated from Chem. Ber.; 102: 152-160(1969). 8p. Dep. NTIS $3.00.

The mass spectra of the tricyclopentadienyl metal complexes of titanium, praseodymium, holmium, thulium, ytterbium, lutetium, arsenic, and antimony, of the tetracyclopentadienyls of thorium and uranium and of some cyclopentadienyl metal halides of these elements are reported and the fragmentation processes discussed. The investigations are supplemented by measurements of the ionization energies of the complexes and of the appearance energies of a series of ionic fragments, from which the dissociation energy which must be used in decomposition of the ions was calculated. (auth)

18033 (RFP-Trans-138) PLUTONIUM HEXAFLUORIDE, ITS PREPARATION AND PROPERTIES. Vanka, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 27 Jul 1973. Translation of Fluorid Plutoniovy, Jeho Priprava a Vlastnosti, 1970. 63p. Dep. NTIS $5.25.

Data on plutonium hexafluoride preparation and properties reported up to April 1970 are reviewed. PuF_6 is usually prepared by direct fluorination of PuF_4 or PuO_2. The physical properties are similar to those of UF_6. The compound is thermodynamically unstable and can be easily reduced to PuF_4 by thermal and radiolysis decomposition or by chemical reagents. Other chemical reactions, methods of separating U and Pu hexafluorides and safe handling of plutonium hexafluoride are discussed as well. (auth)

18034 ELECTRONIC CONDUCTIVITY IN MOLTEN LITHIUM CHLORIDE–POTASSIUM CHLORIDE EUTECTIC. Heus, R. J.; Egan, J. J. (Brookhaven National Lab., Upton, NY). J. Phys. Chem.; 77: No. 16, 1989-1993(2 Aug 1973).

Polarization measurements, similar to those used in the solid state, have been employed to measure a small electronic component of conductivity in molten LiCl–KCl eutectic in the presence of a larger ionic component of conductivity. Convection in the melt has been eliminated. Current-potential curves have been obtained on the cell Ta|LiCl–KCl(l)eut|LiCl–KCl(l), $PbCl_2$ (5% wt)|Pb to obtain the electron conductivity and on the cell C|LiCl–KCl(l)eut|C–Cl_2 to obtain the electron hole conductivity. Applications of the results to problems of molten salt electrochemistry are given including measuring activity of uranium in liquid alloys. (auth)

18035 PLUTONIUM CHEMIST'S PERIODIC TABLE. Cleveland, J. M. (Comp.). Golden, CO; Dow Chemical Company. ([nd]). 1p. Free.

A plutonium chemist's periodic table is presented that depicts all the compounds and alloys of plutonium as well as their physical constants (crystal structure, melting or decomposition temperature). The plutonium oxidation potentials, physical constants of plutonium, and radii of plutonium ions are also included. (DHM)

18036 INVESTIGATION BY MOESSBAUER SPECTROSCOPY OF THE AFTER-EFFECTS OF THE ^{119m}Sn ISOMERIC TRANSITION IN SOME TIN COMPOUNDS. Llabador, Y.; Friedt, J. M. (Centre National de la Recherche Scientifique, Strasbourg). J. Inorg. Nucl. Chem.; 35: No. 7, 2351-2359(Jul 1973).

Chemical after-effects following the isomeric transition (IT) of ^{119m}Sn were investigated by Moessbauer emission spectroscopy in tin(II) perchlorate: $Sn(ClO_4)_2 \cdot 3H_2O$ and in a few organotin compounds: $SnBu_4$, $SnBu_2Cl_2$ and $SnBu_2SO_4$ (Bu = butyl). In all cases, the proportion of aliovalent species is high. The gamma-radiolytic decomposition of the same compounds was studied by Moessbauer absorption spectroscopy. A close similarity appears between the emission and the absorption spectra. The results of the source experiments are discussed in terms of the autoradiolysis model. (auth)

18037 PROPERTIES OF THORIA OBTAINED BY THERMAL DECOMPOSITION OF THORIUM SALTS. Hayashi, H.; Watanabe, T. (Tokushima Univ., Japan). Nippon Kagaku Kaishi; 1973: No. 4, 858-860(Apr 1973). (In Japanese).

Properties of thoria obtained by thermal decomposition of thorium nitrate and oxalate were studied. Thorias from nitrate were dense aggregate like crushed glass about 50 μ in size, while those from oxalate were obtained in powdered form smaller than 2.5 μ. A photograph (×400) is given. The strongly heated nitrate in muffle for 3 hr gave thoria with a particle density of 7.9 to 9.3 g/cm^3. Thoria from oxalate calcined under the same conditions was 3.2 to 3.7 g/cm^3, indicating porous structure. No difference were observed in crystallite size by x-ray powder data. (auth)

18038 EXTRACTION OF CERTAIN ANIONIC ACTINIDE COMPLEXES FROM AQUEOUS SOLUTIONS BY LONG CHAIN ALKYL AMMONIUM COMPOUNDS. 2. Thorium(IV-Thiocyanate System. Sato, T. (Shizuoka Univ., Hamamatsu, Japan); Kotani, S.; Good, M. L. J. Inorg. Nucl. Chem.; 35: No. 7, 2547-2554(Jul 1973).

The extraction of the thorium(IV) thiocyanato complex anionic species from hydrochloric acid solutions by a long chain quaternary ammonium salt in benzene was investigated under different conditions. The absorption spectra of both the aqueous and organic phases were examined, and the infrared and high resolution nuclear magnetic resonance spectral studies were made of the organic phases. The mechanism of the extraction is discussed on the basis of the results obtained. (auth)

18039 STATE OF MICROQUANTITIES OF HEXAVALENT URANIUM IN AQUEOUS SOLUTIONS. Davydov, Yu. P.; Dfremenkov, V. M. (Inst. of Nuclear Energy, Minsk). Dokl. Akad. Nauk BSSR; 17: No. 3, 248-251(Mar 1973). (In Russian).

The state of U(VI) in aqueous solutions at a concentration of 4×10^{-7} molar is discussed. The U proved to be in an ionic form at a pH of 5.0 to 11.0 by the methods of filtration through a cellophane filter, adsorption on glass, desorption, and migration in an electric field. From pH 5 to 11 U(VI) is in a pseudocolloidal state. A calculation of the percent in a hydrolyzed form as functions of the U concentration and the pH of the solution showed that the pseudocolloid state was caused by adsorption of the monomeric hydrolyzed form of U on the colloidal impurities in the solution. (tr-auth)

18040 COMPREHENSIVE INORGANIC CHEMISTRY. Volume 5. Actinides, Master Index. Trotman-Dickenson, A. F. (Ed.). Oxford; Pergamon Press (1973). 715p.

The volume deals with the actinides (actinium, thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, lawrencium). (UK)

18041 CHARGING OF RADIOACTIVE PREPARATIONS. Gromov, V. V.; Spitsyn, V. I. Sov. Radiochem. (Engl. Transl); 14: No. 6, 825-833(1972).

Translated from Radiokhimiya; 14: No. 6, 795-804(1972).

The formation and distribution of charges on the surface of radioactive preparations was analyzed. Formulas were proposed for the calculation of the charge on the surface of radioactive solids in various media. It was established that radioactive dielectrics have on the surface a layer with a distribution of charges that is nonuniform with respect to depth, the thickness of which is equal to the range of charged particles with maximum energy in the radiation spectrum of the given isotope. The values of the charge of the surface of certain radioactive conductors and dielectrics were measured [Ni, Zn Ge(Sb), glass + ^{90}Sr, $SrSO_4$, etc.]. The experimental data obtained are in satisfactory agreement with the theoretical calculations. It was found that the charging of radioactive solids can substantially influence their physicochemical properties (kinetics of dissolution, sorption of charged particles). (auth)

18042 THERMOLYSIS, X-RAY DIFFRACTION DATA, AND IR SPECTRA HEXATHIOCYANATOCHROMATE COMPLEXES OF URANIUM(III) WITH DIMETHYLFORMAMIDE, PYRIDINE, ANTIPYRINE, AND AMIDOPYRINE. Vyatkina, A. S.; Serebrennikov, V. V. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 848-851(1972).

Translated from Radiokhimiya; 14: No. 6, 818-822(1972).

The ir spectra, crystalline characteristics, and thermolysis of compounds with composition $[UAm_x][Cr(SCN)_6]$ were studied, where Am is amidopyrine, antipyrine, dimethylformamide, or pyridine. X-ray diffraction patterns are given. (auth)

18043 COMPLEX FORMATION OF ACTINIUM. II. Determination of the Composition and Stability Constants of Complex Compounds of Actinium with Oxalic and 1,2 Diaminocyclohexanetetraacetic Acids by the Method of Electromigration. Makarova, T. P.; Sinitsyna, G. S.; Shestakova, I. A.; Stepanov, A. V.; Shestakov, B. I. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 852-855(1972).

Translated from Radiokhimiya; 14: No. 6, 822-826(1972).

The stability constants of oxalate and 1,2-diaminotetraacetate complexes of actinium were determined by the method of electromigration on quartz sand: $\beta_1 = (2.3 \pm 0.1) \times 10^4$ | $AcC_2O_4|^+$, $\beta_2 = (1.2 \pm 0.4) \times 10^7$ | $Ac(C_2O_4)_2|^-$, and $\beta_1 = (5.5 \pm 1.2) \times 10^{15}$ | $AcY|^-$. (auth)

18044 SULFATE COMPLEXES OF URANYL WITH HYDROGEN PEROXIDE. I. Investigation of Equilibria in the System UO_2^{2+}–H_2O_2–SO_4^{2-}–H_2O. Gurevich, A. M.; Susorova, N. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 861-866(1972).

Translated from Radiokhimiya; 14: No. 6, 831-836(1972).

The mechanism of the interaction of sulfate complexes of uranyl with hydrogen peroxide was investigated. The reactions of formation of the monoperoxo–trisulfato– diuranylate ion $[(UO_2)_2(OO)$

$(SO_4)_3]^{4-}$ and the diperoxo–disulfato–diuranylate ions $[(UO_2)_2(OO)_2(SO_4)_2]^{4-}$ were studied. The stability constants of these compounds were determined. (auth)

18045 CHEMICAL CONSEQUENCES OF ELECTRON CAPTURE $^{125}Xe \rightarrow {}^{125}I$ IN HYDROCARBONS. Zaitsev, V. M.; Kirin, I. S.; Serova, V. A.; Tikhonov, V. I. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 900-905(1972).

Translated from Radiokhimiya; 14: No. 6, 869-876(1972).

The yields of ^{125}I in organic form in the electron capture of ^{125}Xe in heptane, hexane, and cyclohexane were determined under various conditions. The distribution of ^{125}I among various organic compounds was studied by means of radio gas-chromatographic analysis. A substantial influence of the phase state and conditions of decay of ^{125}Xe on the forms of stabilization of ^{125}I was detected. The possibility of using processes of electron capture of ^{125}Xe for the effective synthesis of compounds labeled with iodine-125 without carriers with the highest possible specific activity was demonstrated. (auth)

18046 THERMOPHYSICAL PROPERTIES OF THE ACTINIDES IN THE LIGHT OF D. I. MENDELEEV'S PERIODIC LAW. Dobretsov, V. N.; Arkhipov, V. A.; Ustinov, V. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 913-915(1972).

Translated from Radiokhimiya; 14: No. 6, 883-885(1972).

An analysis of the experimental results in the light of the Mendeleev periodic system indicates a regular nature of the variation of the thermophysical properties and permits prediction of the order of magnitude of the specific heat, thermal conductivity, and thermal diffusivity for the elements of the actinide group. The order of magnitude of the thermophysical characteristics of the actinides can be predicted on the basis of the general principles of their variation. Thus, the thermal conductivity for the actinides evidently does not exceed 0.015 cal/cm · sec · deg, the thermal diffusivity 0.02 cm^2/sec, and the heat capacity 0.04 cal/g · deg. (auth)

18047 EFFECTS OF XENON DIFLUORIDE ON AQUEOUS SOLUTIONS OF NEPTUNIUM AND PLUTONIUM IN VARIOUS OXIDATION STATES. Gusev, Yu. K.; Peretrukhin, V. F.; Shilov, V. P.; Kirin, I. S. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 919-921(1972).

Translated from Radiokhimiya; 14: No. 6, 888-890(1972).

The action of XeF_2 on aqueous alkaline and acid solutions of tetra-, penta-, and hexavalent neptunium and tri-, tetra-, and hexavalent plutonium was studied. Np and Pu can be oxidized in acid solutions to the hexavalent state, but not to the heptavalent state. In alkaline media oxidation to the heptavalent state is possible. (JGB)

18048 INFLUENCE OF ELECTRON ACCEPTORS ON THE REACTION OF ^{125}I ATOMS FORMED IN THE PROCESS $^{125}Xe \rightarrow {}^{125}I$ IN CYCLOHEXANE. Zaitsev, V. M.; Serova, V. A.; Tikhonov, V. I. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 951-952(1972).

Translated from Radiokhimiya; 14: No. 6, 911-913(1972).

The yields of ^{125}I in organic forms in the case of electron capture of ^{125}Xe in cyclohexane under various conditions were determined, and the composition of the organic compounds formed, labeled with ^{125}I, was determined by radiogas-chromatographic analysis. A substantial influence of electron acceptors on the reactions of ^{125}I atoms, formed in the process $^{125}Xe \rightarrow {}^{125}I$ in cyclohexane, was detected. (auth)

18049 CO-CRYSTALLIZATION OF RADON AND XENON FLUORIDES. Nefedov, V. D.; Toropova, M. A.; Avrorin, V. V.; Dudkin, B. N. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 978-979(1972).

Translated from Radiokhimiya; 14: No. 6, 930-931(1972).

A study of the coprecipitation of radon fluoride with $XeF_2 \cdot 2IF_5$ is reported. The isomorphous cocrystallization of complexes of radon fluoride and xenon fluoride with IF_5 indicate that they are structurally similar, and that, possibly, the product of fluorination of radon is RnF_2. (JGB)

18050 POSSIBILITY OF PRODUCTION OF PLUTONIUM(VIII). Krot, N. N.; Gel'man, A. D.; Zakharova, F. A.; Peretrukhin, V. F.; Pikaev, A. K. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 922-924(1972).

Translated from Radiokhimiya; 14: No. 6, 890-892(1972).

Several reactions were studied in search of a means of oxidation of Pu to the octavalent state. They included the action of ozone on Pu(VII) in solutions with high concentrations of NaOH or KOH, the electrochemical oxidation of Pu(VII) in NaOH solutions, and the interaction of Pu(VII) in concentrated alkali with the H_2O radiolysis products in the presence of N_2O. Also considered were the action of XeF_4 on Pu(VII) in 10M NaOH solution and the interaction of sodium diplutonate with lithium peroxide. None of the reactions produced octavalent plutonium. (JGB)

18051 SELECTIVE GASEOUS ELECTRODEPOSITION OF LEAD-212 AND THALLIUM-208 FROM RdTh SOURCE. Takemi, H.; Assai, N.; Shiagawa, M. (Osaka Univ., Suita, Japan). J. Nucl. Sci. Technol. (Tokyo); 10: No. 3, 155-162(Mar 1973).

Fractional electrodeposition of ^{212}Pb and ^{208}Tl from RdTh source using a capsule equipped with three electrodes was carried out under normal pressure. The experiment was conducted with variations brought to the applied voltage, the interval between the electrodes, time allowed for deposition, and grid conditions. The active deposit thus obtained was examined by radiochemical and autoradiographical methods. Measurements of the active deposits on the electrodes showed that ^{212}Pb had deposited on the grid net, and ^{208}Tl on the target. The mechanism of the electrodeposition process under electric field with and without a grid is discussed on the basis of the decay pattern shown by each nuclide. (auth)

18052 TECHNETIUM BONE SCANNING MEDIUM. McRae, J.; Van Dyke, D. C.; Yano, Y. (to United States Atomic Energy Commission). U. S. Patent 3,735,001. 22 May 1973. Filed date 24 May 1972. 6p.

An aqueous solution of ethane-1-hydroxy-1,1-diphosphonate [(1-hydroxyethylidene) diphosphonic acid] is added to an acidic solution of stannous chloride and mixed. $^{99m}TcO_4$ in isotonic saline solution is then added and the mixture is again mixed. The solution is adjusted to a pH of about 6 to 7 yielding a preparation appropriate for injection into a subject. The medium is highly specific with respect to deposition in the skeleton while troublesome and undesired effects such as colloid formation, binding to blood proteins, localization in the kidneys, etc., are avoided. (auth)

18053 SYNTHESIS, CHEMISTRY, AND SPECTROSCOPY OF SOME TRIS(PENTAHAPTOCYCLOPENTADIENYL)URANIUM(IV) ALKYL AND ARYL COMPOUNDS. Marks, T. J.; Seyam, A. M.; Kolb, J. R. (Northwestern Univ., Evanston, IL). J. Amer. Chem. Soc.; 95: No. 17, 5529-5539(22 Aug 1973).

The systematic high yield syntheses of a number of $(h^5\text{-}C_5H_5)_3UR$ compounds from $(h^5\text{-}C_5H_5)_3UCl$ and the corresponding RLi or RMgX reagents are reported. The new compounds are characterized by chemical and magnetochemical means and by vibrational and NMR spectroscopy. The allyl compound has a ground state monohaptoallyl geometry and is fluxional. In the isopropyl compound restricted rotation is observed about the U–R bond, indicating considerable crowding of ligands around the central metal. Analysis of the isotropic NMR chemical shifts indicates the contribution of large contact shifts; the mechanism of spin distribution involves negative spin density at the α-carbon atom of the alkyl or aryl group and is qualitatively in accord with SCF INDO molecular orbital calculations. The U–C bond is susceptible to attack by protonic solvents and, hence, is somewhat ionic. Most of the new compounds exhibit surprisingly high thermal stability, the general order of stability determined by kinetic studies in toluene solution being primary > secondary > tertiary. In the thermolysis, β elimination of olefin does not occur to any major extent, but intramolecular abstraction of hydrogen from a cyclopentadienyl ring occurs yielding RH; this takes place with essentially complete retention of stereochemical configuration at the α carbon atom of R. A homolytic U–C bond scission producing a highly constrained caged radical pair, or a concerted elimination of RH, explains these observations. (auth)

18054 CRYSTAL STRUCTURE OF $Ni(NH_4)_2[(UO_2)_2F_5] \cdot 6H_2O$. Mikhailov, Yu. N.; Udovenko, A. A.; Kuznetsov, V. G.; Butman, L. A.; Kokh, L. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Zh. Strukt. Khim.; 14: No. 1, 170-172(1973). (In Russian).

Crystalline $Ni(NH_4)_2[(UO_2)_2F_5] \cdot 6H_2O$ was shown by automatic diffractometer studies to possess a basic structural unit of a dimeric complex anion $[(UO_2)_2F_5]^{4-}$, cations of Ni, ammonium, and water. The dimeric anion consists of two pentagonal bipyramids with a common F–F rib. The U–U distance in the dimer is 3.92 Å; other interatomic distances and angles are listed. (KSW)

18055 THERMODYNAMIC STABILITY CONSTANTS OF URANIUM(VI) COMPLEXES OF HYDROXAMIC ACIDS IN DIOXANE-WATER MEDIUM. Gaikwad, M. D.; Tandon, S. G. (Government Science Coll., Raipur, India). Indian J. Chem.; 11: No. 2, 188-190(Feb 1973).

Thermodynamic stability constants of uranium(VI) complexes of several hydroxamic acids, viz. N-phenylbenzo-, N-phenyl-n-butyro-, N-phenylvalero-, N-phenyl-m-methoxybenzo-, N-phenyl-p-chlorobenzo- and N-phenyl-3,5-dinitrobenzohydroxamic acids, were determined at 35°C without adjusting ionic strength employing Bjerrum–Calvin titration technique. The orange–red complexes are stable in the pH range 2.5 to 5.6. The mean activity coefficient ($y\pm$) required for the calculation of thermodynamic constants have been computed for 50% dioxane–water medium

from Harned and Oven's data. The effect of substituents in the ligand on the stabilities of complexes is discussed. (auth)

18056 LANTHANIDES AND ACTINIDES. Annual Survey Covering the Year 1971. Calderazzo, F. (Univ., Pisa, Italy). J. Organometal. Chem. (Amsterdam); 53: 173-178(1 Jun 1973).

A review of the literature dealing with organometallic derivatives of lanthanides and actinides is presented. (DHM)

18057 ^{99m}Tc–IRON HYDROXIDE AGGREGATES: A RADIOPHARMACEUTICAL FOR LUNG SCANNING. Singh, B.; Jaiswal, D. K.; Chander, J. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). Indian J. Radiol.; 25: No. 4, 283-286(Nov 1971).

From 2nd annual conference of Society of Nuclear Medicine; Delhi, India (21 Oct 1970).

A method for preparation of ^{99m}Tc–iron hydroxide aggregates on a laboratory scale is described and its use as a radiopharmaceutical for lung scanning is compared with the usually used macroaggregated human serum albumin labeled with ^{131}I (MAA–^{131}I). In the first step of the procedure, ^{99m}Tc was processed from ^{99}Mo solution by drying the solution, dissolving the dry form in HCl, washing it on alumina column with methyl ethyl ketone (MEK) and finally eluting the column with MEK containing 5% of 0.01 N HCl. In the second step ^{99m}Tc–iron hydroxide aggregates were obtained from ^{99m}Tc solution in saline by treating with ferrous ammonium sulphate solution and gelatin solution. Lung scintiscans of dogs compared favorably with those done with MAA–^{131}I. The advantages of ^{99m}Tc–iron hydroxide aggregates over MAA–^{131}I are (i) short half-life of 6 hours, (ii) monoenergetic γ rays of 140 keV from ^{99m}Tc, (iii) delivery of low dose of radiation to patients, (iv) more uniformity of particle size i.e., 85 to 90% of the particles are between 20 to 50 microns size and (v) ease of preparation. (INIS)

18058 PHYSICO-CHEMICAL STUDIES ON THE COMPLEX FORMATION OF ZIRCONIUM AND THORIUM WITH SOME ORGANIC ACIDS. Pande, C. S.; Misra, G. N. (Lucknow Univ., India). Indian J. Chem.; 11: No. 3, 292-293(Mar 1973).

Zirconyl chloride reacts with 3-nitrosalicylic acid (3-NSA), 5-nitrosalicylic acid (5-NSA), 3,5-dinitrosalicylic acid (3,5-(DNSA), and 5-bromosalicylic acid (5-BSA) to form 1:1 complexes. Thorium nitrate yields 1:1, 1:2, and 1:3 complexes with 3-NSA and 5-NSA and 1:1 and 1:2 complexes with 3,5-DNSA and 5-BSA. The stoichiometries were confirmed by analytical, conductometric, and potentiometric data. (auth)

18059 SPECTROPHOTOMETRIC STUDIES OF UO_2^{2+} COMPLEXES WITH THIOSALICYLIC ACID AND THIOSALICYLAMIDE. Lewicka, M. (Dept. of General Chemistry, Bialystok, Poland). Rocz. Chem.; 47: No. 4, 719-725(1973). (In Polish).

Thiosalicylic acid and thiosalicylamide form colored complexes with UO_2^{2+} ions in an aqueous ethanol medium. The composition of the complexes formed was determined by Job's and Babko's methods. The molar compositions of the complexes formed are: UO_2^{2+}: ligands = 1:1 and 1:2. The composition of the complexes depends on pH. Stability constants were determined by Rose and Drago method. It was found that thiosalicylamide formed more stable complexes with UO_2^{2+} ions than thiosalicylic acid. (auth)

18060 THIRD INTERNATIONAL TRANSPLUTONIUM ELEMENT SYMPOSIUM, ARGONNE, ILLINOIS, OCTOBER 20–22, 1971. Argonne, IL; Argonne National Laboratory (1971). 47p. (CONF-711078-(Absts.)).

From 3rd international transplutonium element symposium; Argonne, Illinois, USA (20 Oct 1971).

Abstracts of forty of the forty-one papers presented at the Third International Transplutonium Element Symposium are presented. (DHM)

Radioactive Waste Treatment

Refer also to abstracts 17912 and 18919.

18061 (DP-MS-71-88) DESORPTION OF RADIOIODINE FROM ACTIVATED CARBON IN AN INTENSE GAMMA RADIATION FIELD. Evans, A. G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 16 May 1972. Contract AT(07-2)-1. 26p. (CONF-720614-10). Dep. NTIS $3.50.

From 17th annual meeting of the Health Physics Society; Las Vegas, Nevada, USA (12 Jun 1972).

Radioiodine adsorbed on activated carbon following a major reactor accident can be converted to organic iodides and desorbed in an intense radiation field. The rate of formation and desorption of the organic iodides is a function of radiation field strength, relative humidity, carbon type and service history, and possibly the operating temperature of the adsorber bed. Free radical reactions involving iodine, water, carbon, and an intense radiation field are proposed as the mechanism of organic formation. Data are presented for desorption rates in humid air from several types of carbon and inorganic-base iodine absorbers at a γ dose rate of 1.5×10^7 rads/hour (^{60}Co source). Desorption rates from selected adsorbers are also given for lower dose rates and with varying purge gas compositions as well as under varying temperature and exposure conditions outside the radiation field. (auth)

18062 (EUR-4981) RADIOACTIVE POLLUTION: ITS ELIMINATION. Part II. Radioactive Wastes Processing Plants. Mosselmans, G.; Vaccarezza, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jun 1973. 27p. (In French). Dep. NTIS (U.S. Sales Only) $3.50. EUR FB 40,-.

Methods to eliminate radioactive pollution are described. A brief description is given of the treatment plants for each category of waste at Ispra establishment of the Joint Nuclear Center of the European Community. (auth)

18063 (IAEA-R-667-F) INCORPORATION OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTES IN BITUMEN. Final Report for the Period January 1, 1969–30 June 1971. Ghejan, I.; Barbul, S.; Ciples, L.; Breban, I.; Iorga, D. (International Atomic Energy Agency, Vienna (Austria)). Oct 1971. 65p. (In French).

Several processes of concentrating radioactive wastes are cited, especially the method of embedding the concentrated radioactive liquids in bitumen. Two distinct lines of research become apparent. The first has as its purpose the elaboration of a thorough study of the blown bitumens currently produced in Romania and especially the determination of the qualities of bitumens as an incorporation medium. The study deals with the resistance of the bitumens to γ radiation as well as their stability during storage in distilled water. The second is centered on the making of compounds separated from bitumen by means of suitable solvents for the purpose of determining the stability of these compounds when they are subjected to the action of radiations. These researches have as their purpose the production of special types of bitumen with improved characteristics for incorporating radioactive wastes. Several laboratory systems are described, and various bitumens used are cited as well as their physicochemical characteristics. Finally two methods of incorporation are cited before arriving at the criteria for the choice of the type of bitumen to use. Then the resistance to storage of incorporated products is described as well as the resistance of the bitumens to γ rays. The study is concluded with tests on the behavior toward radiation of certain separate elements. Three components (oils, resins, and asphaltenes) were tested at dose levels of 10^8 rads for a rate of 10^5 rad/hr. The comparative results are presented in several tables that show the analytical changes after irradiation. It is evident that the asphaltenes have the least resistance to irradiation which indicates the use of bitumens with a reduced content in asphaltenes for the incorporation of radioactive wastes. (tr-INIS)

18064 (LA–5303-MS) APPARATUS FOR THE REDUCTION OF TRITIUM EMISSIONS INTO THE ATMOSPHERE. Dube, C. M.; Coffin, D. O.; Stoll, R. D. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 4p. Dep. NTIS $4.00.

A method is described for the removal of tritium from exhaust gases. The equipment and techniques are presented for the conversion of tritium to tritium water using a catalytic converter and the subsequent capture of the tritium water on molecular sieves. The test gas contained 0.5% tritium, and using flow rates between 100 cm^3/min and 500 cm^3/min, a reduction occurred in the amount of tritium in the exhaust gas by a factor of over 250,000. (auth)

18065 WASTE MANAGEMENT IN REPROCESSING PLANTS. Smiley, S. H. (Atomic Energy Commission, Washington, DC). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 7-8(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

18066 EFFECTS OF CHEMICAL CHARACTERISTICS OF WASTE AND LEACHING CONDITIONS ON THE LEACHING OF ^{137}Cs FROM THE CEMENT–WASTE SOLID. Terashima, Y. (Kanazawa Univ., Japan). Nippon Genshiryoku Gakkaishi; 15: No. 1, 52-59(Jan 1973). (In Japanese).

The leaching characteristics of ^{137}Cs from wastes solidified with cement were studied. The principal results follow. The diffusional leaching rate is a little lower in seawater than in tap water. The diffusion coefficients of ^{137}Cs for leaching from waste solidified with $Ca(NO_3)_2$ solution of 4n weight normality under the condition of 75% water-cement ratio (W/C), with 4n$NaNO_3$, 0.5n-$Fe(NO_3)_3$, 0.5n$Al(NO_3)_3$, 0.2n$Ca(NO_3)_2$, and 0.2n$NaNO_3$ solution respectively under the condition of 40% W/C have been determined to range from 2.7×10^{-8} to 8.3×10^{-7} cm^2/sec for leaching into tap water and 1.9×10^{-8} to 3.1×10^{-7} cm^2/sec for that

into seawater. The diffusion coefficients diminish by about 60% when the leaching water temperature is lowered by 20° to 30°C. The coefficients are also reduced by about 50% with increase in pressure from 1 to 300 atm. More than half of the ^{137}Cs co-precipitated with nickel ferrocyanide is turned to leachable ionic state in cement pastes as a result of alkali decomposition of the precipitate. In a cement milk, vermiculite and glauconite are capable of maintaining a high selective exchange capacity for cesium. Then about 98% of the ^{137}Cs adsorbed onto vermiculite can be retained in a cement paste after hardening. (auth)

18067 FIXATION OF ^{90}Sr AND ^{137}Cs IN THE CALCINATION OF SILICATE ROCKS. Rovinskii, F. Ya.; Sinitsyn, N. M.; Morozova, G. K.; Ispravnikova, V. V. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 844-847(1972).

Translated from Radiokhimiya; 14: No. 6, 814-818(1972).

The influence of calcination of sandstones and kaolin in the temperature range 100 to 800° on the degree of desorption of ^{90}Sr and ^{137}Cs was investigated. It was found that the desorption of ^{90}Sr by a 0.1N solution of $Sr(NO_3)_2$ in all the sorbents studied and ^{137}Cs by a 0.1N solution of $CsNO_3$ from kaolin decreases with increasing calcination temperature, and at 800° does not exceed 4 and 7%, respectively. About 80% of the ^{137}Cs undergoes nonexchange sorption on sandstones at room temperature, and their subsequent calcination does not lead to any further reduction of the degree of desorption of ^{137}Cs. An attempt to determine the role of SiO_2 and Al_2O_3 in the fixation of ^{90}Sr and ^{137}Cs by kaolin was undertaken. (auth)

18068 NICKEL FERROCYANIDE FOR THE PURIFICATION OF DEACTIVATION SOLUTIONS. Bagretsov, V. F.; Tolkachev, G. I.; Semenova, L. I. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 885-888(1972).

Translated from Radiokhimiya; 14: No. 6, 854-858(1972).

The chemical and thermal stability of ferrocyanides was studied in order to evaluate their effectiveness for the removal of radiocesium from deactivation solutions. The effect of pH on the extent of Cs removal by Zn, Cu, and Ni ferrocyanides in alkaline media was investigated. Nickel ferrocyanide was found to give the best extraction of the three compounds. At pH 10 sorption of Cs was somewhat higher than at pH 11.5, although the precipitate was less well formed. Allowing the solution to stand for 24h led to a better purification of the solution from Cs. Purification of the solution from Cs was 99.1% when the suspension was separated on an alluvial perlite filter immediately after introduction of the sorbent. (JGB)

18069 ISOLATION OF MICROQUANTITIES OF RADIOACTIVE ISOTOPES FROM LOW-ACTIVITY SEWAGE BY THE METHOD OF FREEZING. Zolotavin, V. L.; Sanatina, V. N.; Kalugina, N. N.; Brovkova, E. V.; Konstantinovich, A. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 967-969(1972).

Translated from Radiokhimiya; 14: No. 6, 923-925(1972).

The purification by freezing of low-activity nontechnological sewage with α activity of 10^{-6} Ci/liter and total β activity of 10^{-7} Ci/liter was studied. The coefficient of purification with respect to α activity reached 200, with respect to β activity 25. The total content is lowered 14-fold, and the hardness reduced 5-fold in comparison to the initial water. (JGB)

18070 SOLIDIFICATION OF HIGH-LEVEL RADIOACTIVE WASTES. Krause, H. (Kerforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech.; 45: No. 10, 658-663(1973). (In German).

A review is presented of the basics of vitrification, storage conditions, and the long-time behavior of the highly radioactive final products. The inclusion of fission product compounds in ceramic materials is also discussed. (GE)

Radioisotope Production

Refer also to abstracts 17849, 18411, and 19154.

18071 (RFP-1875) BATCH TWO-STAGE COUNTERCURRENT MODE FOR LIQUID PLUTONIUM–MOLTEN SALT EXTRACTION OF AMERICIUM. Knighton, J. B.; Long, J. L.; Franchini, R. C.; Auge, R. G.; Brown, J. C.; Meyer, F. G. (Dow Chemical U.S.A., Golden, Colo. Rocky Flats Div.). 31 Jul 1973. Contract AT(29-1)-1106. 9p. Dep. NTIS $4.00.

The production molten salt extraction process for the removal of americium from plutonium metal was modified from cross-current to countercurrent flow of salt and metal. The $MgCl_2$ content of the KCl–NaCl–$MgCl_2$ salt was increased from 6 wt % to 8 wt %. These changes have resulted in a reduction in the amount of salt generated per kilogram of plutonium processed by a factor of approximately two without any significant sacrifice in americium removal efficiency. (auth)

18072 PRODUCTION OF ^{113m}In USING TRIDODECYLAMINE. Adel, M. S. (Cairo Univ.); Alian, A.; Sanad, W. Radiochem. Radioanal. Lett.; 14: No. 4, 241-246(30 Jul 1973).

A method is described for the rapid production of ^{113m}In from irradiated tin. The method is based on the extraction of ^{113}Sn by tridodecylamine (TDA) from 1.2N HCl. Accumulated ^{113m}In can then be milked out from the loaded solvent into 1.2N HCl. The indium isotope produced was found to be free from tin isotopes as well as from other activities. (auth)

18073 COLUMNS FILLED WITH CRYSTALLINE TELLURIUM FOR THE PRODUCTION OF RADIOCHEMICALLY PURE PREPARATIONS OF ASTATINE. Bochvarova, M.; Do Kim Tyung; Dudova, I.; Norseev, Yu. V.; Khalkin, V. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 889-895(1972).

Translated from Radiokhimiya; 14: No. 6, 858-865(1972).

Astatine is entirely sorbed by powdered crystalline tellurium from 6M solutions of HCl, 0.1M with respect to $SnCl_2$. Sorption is not hindered by thorium (~50 mg/ml), 1M HBr, and 0.1M HI, as well as high rates of filtration (up to 100 ml/cm^2 · min) of the astatine-containing solutions through a layer of tellurium. Astatine is eluted from the sorbent (~90%) by solutions of 1 to 2M NaOH. Astatine exists in the alkaline solution obtained in the form of the astatide ion. A system of two columns, filled with tellurium powder with grain size 100 to 200 mesh, permits the isolation of astatine from 2 to 3 g of thorium, irradiated with 660 MeV protons, within 1.5 to 2 h. The volume of the astatine preparation is no more than 0.3 ml; random radioactive contaminations are less than 5×10^{-2}%, tellurium content ~3 μg/ml, chemical yield of astatine 80 ± 5%. (auth)

18074 PRODUCTION OF ^{131}Cs WITHOUT A CARRIER AND ESTIMATION OF THE CROSS SECTION OF THE REACTION $^{131}Cs(n,\gamma)^{132}Cs$ ON THERMAL NEUTRONS. Malinin, A. B.; Levin, V. I.; Kurchatova, L. N. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 896-899(1972).

Translated from Radiokhimiya; 14: No. 6, 866-869(1972).

The optimum conditions of irradiation of barium targets, ensuring the production of a maximum yield of ^{131}Cs for a set value of the ^{132}Cs impurity, were determined. A simple method was proposed for the isolation of ^{131}Cs without a carrier from neutron-irradiated barium carbonate, based on two-step precipitation of barium (in the form of the nitrate, and then of the carbonate). The yield of ^{131}Cs in the silation was no lower than 90%. The ^{131}Ba impurity was no higher than 0.01% of the activity of ^{131}Cs. In the case of irradiation of barium in a neutron flux of 2.4×10^{13} neutrons/cm^2 · sec for 21 days and exposure of the target for seven days, it is possible to obtain about 10 mCi of ^{131}Cs per gram of barium with a ^{132}Cs impurity of about 0.1% with respect to activity. The cross section of the reaction $^{131}Cs(n,\gamma)^{132}Cs$ on thermal neutrons, equal to (250± 40) barns, was estimated. (auth)

18075 USE OF ION EXCHANGE CHROMATOGRAPHY FOR THE ISOLATION OF PROMETHIUM-147. Maslova, G. B.; Nazarov, P. P.; Chuveleva, E. A.; Chmutov, K. V. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 939-940(1972).

Translated from Radiokhimiya; 14: No. 6, 902-903(1972).

The separation of fragment rare earth elements by a chromatographic method for the production of ^{147}Pm of a high degree of purity is reported. Elution chromatography was used for the purification of small quantities of Pr (~250 mCi), but this method was ineffective for gram quantities. Displacement complex-forming chromatography was used for the isolation of 1500 Ci of Pr, the method being more effective with increasing amounts of Pr. (JGB)

18076 POSSIBILITY OF PRODUCING ^{132}Cs WITHOUT A CARRIER. Malinin, A. B.; Kurchatova, L. N. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 941-943(1972).

Translated from Radiokhimiya; 14: No. 6, 904-905(1972).

A method for the production of ^{132}Cs without a carrier is proposed. Barium carbonate is irradiated in a reactor (not at large neutron fluxes), and ^{132}Cs is isolated from it without a carrier. Then a target of ^{131}Cs is irradiated at large neutron fluxes (10^{15} neutrons/cm^2 · sec), for a time during which a usable impurity of ^{131}Cs and optimum yields of ^{132}Cs can be obtained. (JGB)

18077 ISOLATION OF RADIOACTIVE ISOTOPES OF RUBIDIUM-83, 84 WITHOUT A CARRIER FROM SODIUM BROMIDE IRRADIATED ON A CYCLOTRON. Sevast'yanov, Yu. G.; Erlychenko, V. P. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 970-971(1972).

Translated from Radiokhimiya; 14: No. 6, 925-926(1972).

Experiments were conducted to find optimum conditions for the separation of microquantities of rubidium from macroquantities of sodium bromide using HCl as the eluent. Aqueous solutions of NaBr containing radioactive isotopes ^{83}Rb and ^{22}Na and the cation

exchange resin Dowex 50X8 were used. Results indicate that the use of a 1M HCl solution ensures the separation of Rb and Na and leads to a substantial reduction in the volume of the wash solution. (JGB)

18078 PRODUCTION OF INDIUM-114m WITHOUT A CARRIER. Iofa, B. Z.; Novikova, N. A.; Sevast'yanov, Yu. G. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 972-973(1972).

Translated from Radiokhimiya; 14: No. 6, 926-927(1972).

A detailed study was made of the extraction of radioactive indium and cadmium from solutions of HCl, HBr, and HI acids using various oxygen-containing organic solvents. Satisfactory results were obtained on the separation of microquantities of ^{114m}In (yield 85%) from large quantities of Cd in solutions of HBr and HI by extraction with di-n-butyl ether. This solvent was used therefore in the production of ^{114m}In without a carrier from cyclotron targets. (JGB)

18079 ^{238}Pu AND ^{244}Cm PRODUCTION PROGRAMME AT THE COMMISSARIAT A L'ENERGIE ATOMIQUE. Berger, R. (CEN, Fontenay-aux-Roses, France); Ducasse, G.; Koehly, G.; Paradis, G. pp 31-47 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In French)

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Several years ago the CEA initiated a program in which ^{238}Pu and ^{244}Cm are produced by irradiating Np and Pu respectively. The targets are manufactured by the CEN at Cadarache and irradiated in the Celestin reactors at the Marcoule center. The irradiated targets are chemically processed by the CEN at Fontenay-aux-Roses. (FR)

18080 GRAM SCALE PRODUCTION OF ^{227}Ac FROM IRRADIATED RADIUM. Baetsle, L. H. (Nuclear Research Center, Mol, Belg.); Demildt, A. C.; Huys, D.; Droissart, A.; Roose, J. pp 95-119 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

Since the start of actinium production at the end of 1969, about 6 g of actinium have been produced of which 2.5 g have been separated and chemically purified. The processing methods based on precipitation and ion exchange techniques were adapted to work with increasing specific activities. Operational experience with the control of the radon isotopes in the hot cell installations and in the adsorption and ventilation units confirmed the possibility of working with large amounts of ^{226}Ra, ^{227}Ac, and ^{228}Th. Considerable effort was devoted to the development of several radiochemical and analytical techniques for off-line process control and materials balance checks. (auth)

18081 PRODUCTION OF URANIUM-232 IN LARGE QUANTITIES. Kim, J. I. (Technische Univ., Munich); Born, H. J.; Kluge, E.; Lieser, K. H. pp 121-142 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

High-isotopic-purity ^{232}U was obtained by irradiating ^{230}Th/^{232}Th mixtures and subsequently irradiating the intermediate product ^{231}Pa in neutron fluxes having high concentrations of epithermal neutrons. The chemical processing of the irradiated ThO_2 and Pa_2O_5 targets was effected by anion exchange in mixed solutions of mineral acids and organic solvents with small added concentrations of HF or by solvent extraction from HCl-HF solutions with diisobutylketone and tributylphosphate. A method of producing large quantities of ^{232}U is presented. (auth)

18082 RADIOACTIVE ISOTOPE GENERATOR OF SHORT-LIVED NUCLIDES. Kato, S.; Kurata, K. (to Dainabot Radioisotope Labs., Ltd.). U. S. Patent 3,740,558. 19 Jun 1973. Filed date 17 Feb 1971. 4p.

A radioactive isotope generator for conducting parent-daughter radionuclide separations and containing a relatively small amount of radioactivity is reported. The generator is made up of a container or column having a parent nuclide within it, the parent nuclide being separated from the remainder of the column by a filter material. As a specific embodiment, the generator is made up of a column having two chambers separated by a filter material, the parent activity being adsorbed on an adsorbent such as alumina and being contained in one of the chambers as a suspension. The open end of the column near the empty chamber is sealed by a puncturable stopper. When the empty chamber is evacuated by means of a syringe inserted through the puncturable stopper, for example, the solution containing the daughter nuclide will pass through the filter and into the empty chamber, from which it is available for use. (auth)

18083 SEPARATION OF ^{32}P FROM IRRADIATED SULFUR. Abrarov, O. A.; Zhuravlev, A. A. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 9, 24-26(1972). (In Russian).

The extraction of ^{32}P from irradiated ^{32}S was studied as a function of the weight of the S from 10 to 200 mg. The organic and aqueous phases were represented by a paraffin-6N HCl system at 95°C, and extraction was carried on for 30 min. The data showed that extraction performance was independent of the total quantity of S irradiated (1.8×10^{13} neutrons/cm^2·sec). (KSW)

Reactor Fuel Reprocessing

Refer also to abstracts 18924 and 20250.

18084 (CEA-CONF-2283) INTERNATIONAL COOPERATION IN THE REALM OF REPROCESSING OF IRRADIATED FUELS. Couture, J. (Commissariat a l'Energie Atomique, Paris (France)). [nd]. 9p. (In French). (CONF-730341-1). Dep. NTIS (U. S. Sales Only) $3.00.

From international cooperation in reactor material and nuclear fuels conference; Paris, France (2 Mar 1973).

Experience gained in the Eurochemic plant and increasing demands have resulted in an attempt to regroup and organize the efforts undertaken in order to form a powerful European irradiated fuel reprocessing industry. (FR)

18085 (JUL-925-CT) PURIFICATION OF BURNER OFF-GASES DURING REPROCESSING OF IRRADIATED HTR FUEL ELEMENTS. Beaujean, H.; Filss, P.; Grahmann, U.; Laser, M.; Merz, E.; Tillessen, U. (Kernforschungsanlage, Juelich (West Germany)). Feb 1973. 106p. (In German). Dep. NTIS (U. S. Sales Only) $7.50.

The condensable and particulate radioactive nuclides like cesium and zirconium released during the burning process were decontaminated by a factor of 10^7 by a series of conventional gas purification steps. Their concentrations in the off-gas were reduced to below the MPC values. The system, porous sintered metal filters in the burner followed by an electrostatic filter in the off-gas treatment plant, was demonstrated as an effective method for the separation of these aerosols. Tritium was removed (DF > 10^2) by molecular sieves or silica gel absorber traps. The release rate of ^{85}Kr was measured continuously during the burning process. Krypton-85 was quantitatively released during the burning of $(U,Th)C_2$ fuels. Only about 7% of the ^{85}Kr was released during burning of $(U,Th)O_2$ fuels irradiated to 10% fifa. Off-gas concentrations of ^{14}C and thoron daughter-products were also determined. The design of a large-scale gas purification system for a nuclear fuel reprocessing plant is also discussed. (auth)

18086 (KFK-1392) BEHAVIOUR OF PLUTONIUM AND URANIUM IN THE WAK FLOWSHEET LABORATORY TESTS IN MIXER-SETTLERS. Ochsenfeld, W.; Hoffmann, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Apr 1973. 35p. (In German). Dep. NTIS (U.S. Sales Only) $3.75.

Laboratory investigations were made into the behavior of plutonium, uranium, and nitric acid in the extraction with 30 vol.% TBP/alkane using the flowsheets calculated by Industriegemeinschaft Kernverfahrenstechnik (IGK) for the Karlsruhe Reprocessing Plant (WAK). According to the WAK process, the Pu-U-coextraction and scrubbing, Pu/U separation with U(IV), and uranium back extraction in the first extraction cycle were studied. Furthermore, the plutonium and uranium second cycle flowsheets were studied. (auth)

18087 APPARATUS FOR LEACHING CORE MATERIAL FROM SHEARED SEGMENTS OF CLAD NUCLEAR FUEL PINS. Odom, C. H.; Kunselman, M. H. (to United States Atomic Energy Commission). U. S. Patent 3,730,689. 1 May 1973. Filed date 12 Feb 1971. 6p.

An apparatus is described for selectively dissolving or leaching one or more solid components of a mixture such as clad nuclear fuel pin segments. The apparatus includes a rotatable, generally cylindrical drum designed to operate with its longitudinal axis disposed horizontally. A plurality of perforated, radially extending, circular partitions are spaced apart along the drum axis to form a series of feed, leaching, and discharge compartments. Axial movement of solids through the drum is restricted by the partitions while the dissolvent is permitted to flow through the perforations therein in a substantially unrestricted manner. Transfer chutes in the shape of slotted, skewed, conical frustums are provided within each leaching compartment for transferring solids between compartments only when the drum rotation is reversed one turn with respect to its normal direction of rotation during a leaching operation. Mixing or agitation of the solids to enhance dissolution is accomplished without solids transfer during rotation

of the drum by perforated mixing baffles which extend axially and radially within the peripheral region of each leaching compartment. Feed and discharge compartments containing transfer baffles are provided at opposite ends of the drum for receiving unprocessed mixtures and for discharging undissolved solids. Means for adding fresh dissolvent and for removing liquid containing dissolved solids are provided at the discharge and feed compartment ends of the drum, respectively. (auth)

18088 BEHAVIOR OF SOME FISSION PRODUCTS IN THE FLUORINATION PROCESS USING BrF_3. Sakurai, T. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 2, 130-131(Feb 1973).

ENGINEERING

Energy Conversion

Refer also to abstracts 18411, 18412, 18414, 18730, 18932, 19902, 20419, and 20655.

18089 (AD-757145) RACK-MOUNTED THERMOELECTRIC POWER SOURCE. Technical Report. Herchakowski, A. (Army Electronics Command, Fort Monmouth, N. J.). Feb 1973. 18p. (ECOM-4083). NTIS.

Design concepts of air-cooled rack-mounted thermoelectric no-break power generating systems, proposed for operating within an integrated shelter or van, to power tactical communication equipment are described. The results of operational tests conducted on an experimental model of an air-cooled thermoelectric system, fabricated on the basis of one of the proposed concepts, are presented. (auth)

18090 (AD-758783) CONSTRUCTION AND TEST OF AN MHD GENERATOR CHANNEL AND ELECTRICAL POWER CONVERTER. Nimmo, R.; Buechler, L.; Irish, K. (Systems Research Labs., Inc., Dayton, Ohio). Nov 1972. Contract F33615-71-C-1425. 165p. (AFAPL-TR-73-5). NTIS.

The AFAPL MHD Facility was placed in operation. A peg wall, diagonally connected MHD channel was constructed, making use of materials evaluated in a Hall channel. Seed handling procedures, a new seeding wheel, and timing relations for the burner, fuel flow, oxygen flow, and seed injection were developed. A series of conductivity tests were conducted, and a conductivity of 10 mho's per meter was established. The MHD generator was run at an output of 800 volts, 125 kW with a 2.2 Tesla magnetic field strength. A 2000 Hz converter was designed, constructed and tested to convert a 600 volts dc input to a 50,000 volts ac output. The MHD generator was operated successfully with the new channel for 15 runs of 4 to 6 seconds each, with no appreciable deterioration of the MHD channel or support equipment. (auth)

18091 (LBL-1773) CALCULATIONS ON A SOLAR ENERGY SYSTEM. Graven, R. M. (California Univ., Berkeley. Lawrence Berkeley Lab.). 8 Mar 1973. Contract W-7405-eng-48. 33p. (CONF-731002-1). Dep. NTIS $3.75.

From international meeting on the solar energy society; Cleveland, Ohio, USA (3 Oct 1973).

A computer program has been used to calculate the amount of energy which can be extracted from a flat plate solar collector. The computations consider latitude, heat loss, daily temperature range, percent cloud cover, sun angle, etc. to determine the feasibility of home-heating for an angularly adjustable solar collector in the northern hemisphere. The program also calculates the energy available from a solar-earth heat pump. The influence of design parameters and the feasibility of using solar energy to generate heat and electricity for a small single family residence have been considered. The electrical energy produced would be used to supply the electrical needs of the residence during the daylight hours; this load is relatively small. In some cases, the energy can be used to heat water or to reduce home heating and air conditioning expenses. All excess electricity is expected to be fed to the existing power grid for credit as it is generated, reducing the need for energy storage devices. Extensions of the program to consider the energy balance for small industrial buildings or medium size solar farms covering shopping centers are also discussed. (auth)

18092 (MDC-G-4404) INVESTIGATION OF COMPATIBILITY BARRIERS BETWEEN PLUTONIA-238 AND NOBLE METALS AT 1500°C. Watrous, J. D.; Walker, J. C.; Ferguson, W. E. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Apr 1973. Contract AT(45-1)-2138. 64p. Dep. NTIS $5.25.

Investigation of compatibility barriers between plutonium-238 oxide and noble metals at 1500°C for the multi-hundred watt (MHW) radioisotope thermoelectric generator program indicated that the barriers tested created detrimental reactions. Variables included in the test matrix were plutonia oxygen content ($PuO_{1.86}$ and $PuO_{2.0}$), barriers (Mo foil/Ir foil, and Mo foil/HfO_2), vented containers (Ir, Pt-30Rh, and Pt-26Rh-8W), external oxygen getters (graphite and Ta-10W), and test duration (1000 and 5000 h). Molybdenum mass transported to the containers and reacted, forming massive coatings and diffusing into the noble metal container walls. The Ta-10W guard containers also mass transported to the outside surfaces of the noble metal container walls. Oxygen species from the plutonia and hafnia were responsible for the refractory metal mass transport. Iridium was attacked less than the two platinum alloys. Presence of graphite resulted in inhibition of mass transport with concurrent undefined structural changes in the plutonia. A recommendation is made to continue system development with a high oxygen content plutonia in an iridium container with a smaller vent than that tested and external graphite without any extraneous barriers in the system. (auth)

18093 (N-73-17717) PERFORMANCE TESTS OF A THERMIONIC CONVERTER WITH AN OXYGENATED CESIUM RESERVOIR. Final Report. Gunther, B.; Lieb, D.; Pigford, T.; Rufeh, F. (Thermo Electron Corp., Waltham, Mass.). Jul 1972. Contract NAS3-14413. 57p. (NASA-CR-121119; TE-4144-14-73). NTIS.

Cesium oxide/cesium solutions as a possible source of oxygen and cesium were investigated. A converter-reservoir system which allows multiple additions of oxygen with intervening thermionic performance tests was developed. The experimental data cover the cesium oxide mole fraction range of 0 to 0.018 with thermionic performance measurements in the emitter temperature range of 1600 to 1900°K. The data showed that the thermionic performance was unaffected by the presence of cesium oxide in this mole fraction range and higher mole fractions appear to be required for the proper oxygen arrival rate at the emitter surface. (auth)

18094 (ORNL-TM-4102) PERFORMANCE OF ALUMINUM SCREEN AND FOIL AS A THERMAL FUSE AND INSULATION FOR ISOTOPE POWER PLANTS. Holcomb, R. S. (Oak Ridge National Lab., Tenn.). Aug 1973. Contract W-7405-eng-26. 71p. Dep. NTIS $5.75.

Fusible insulation composed of aluminum screen and a combination of screen and foil was evaluated as a combined thermal insulation and thermal fuse for the heat-block shield of the reference design power plants of the Isotope Kilowatt Program. The function of the thermal fuse is to prevent overheating of the isotope fuel capsules in the event of the loss of cooling of the heat block by the coolant for the power conversion system. Thermal conductivity and meltdown tests were performed on test specimens of two sizes: 5½ in. OD × 48 in. long and 17 in. OD × 48 in. long. Tests were run with maximum insulation temperatures from 500 to 1050°F in air and nitrogen at pressures from 0.012 mm Hg abs to 15.4 psia and in argon at 15.4 psia. The best results were obtained with insulation composed of an aluminum foil interspersed at every eighth layer of screen. The thermal conductivity for this material was found to be 0.077 Btu/hr-ft-°F at a mean insulation temperature of 600°F in nitrogen at 1 psia or argon at 15.4 psia. The meltdown results yielded maximum average heat block surface temperatures of 1520°F with the heat block vertical and 1580°F with the heat block horizontal. (auth)

18095 (TID-22659) PROCEEDINGS OF THE MEETING ON APPLIED THERMIONIC TECHNOLOGY HELD AT ATOMIC ENERGY COMMISSION HEADQUARTERS BUILDING, GERMANTOWN, MARYLAND, MAY 13-14, 1965. Prosser, J. M. (ed.) (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1967. 410p. (CONF-650586-). Dep. NTIS $22.50.

Declassified Oct 1972.

Nineteen papers were presented at four sessions of the conference. Information presented at the sessions included isotope thermionics; thermionic fuels and materials; out-of-pile diodes and reliability; and fission-heated diode experiments. (RCK)

18096 (UCRL-51321) OPTIMIZATION OF COLLECTOR EFFICIENCY FOR DIRECT ENERGY CONVERTERS FOR FUSION REACTORS. Moir, R. W.; Barr, W. L.; Haratani, T. N. (California Univ., Livermore. Lawrence Livermore Lab.). 6 Jun 1973. Contract W-7405-eng-48. 15p. Dep. NTIS (U. S. Sales Only) $4.00.

A computer code written in Fortran and called COP calculates the ideal efficiency of a direct energy converter. The numerical procedure is to iteratively solve a set of equations derived from a standard variational method. The solution gives the potentials to be placed on the ideal collector elements as well as the efficiency of energy recovery. An arbitrary ion energy distribution can be used by reading in a table of numbers. Several distributions are analyzed and compared to an approximate efficiency, $\eta = 1 - 1/N$ where N is the number of collector stages. (auth)

18097 SELF GENERATING THERMOELECTRIC CONVERTER. Cathey, L. C. (to United States Atomic Energy Commission). U. S. Patent 3,738,873. 12 Jun 1973. Filed date 23 Dec 1964. 4p.

A single body semiconductor made of a radioactive element having a radioisotope heat source of the same element as an integral part thereof is described. The semiconductor is a compound in-

cluding radioactive actinide element, such as plutonium, uranium or thorium, and the heat source is a heat-producing radioisotope of the same element. Suitable doping impurities, diffused into part of the semiconductor bar, shift the electrical potential distribution across the center portion to produce the thermoelectric element. (Official Gazette)

18098 POWER CONDITIONER. Schuerholz, D. L. U. S. Patent 3,737,689. 5 Jun 1973. Filed date 20 Aug 1965. 12p.

A power conditioner and radioisotope heated thermionic generator, having a self-starting dc-dc converter, and a dependable, electronic shunt regulator for shunting excess power at the beginning of the generator lifetime and zero power at the end of the generator lifetime, and for maintaining a steady, dependable output for a load even if the load current changes from a predetermined level are described. (Official Gazette)

18099 INFLUENCE OF ASSUMED VALUES OF CROSS SECTIONS OF ELASTIC COLLISIONS IN LOW-TEMPERATURE PLASMA ON PARAMETERS OF ELECTRIC CONDUCTIVITY. Kordus, A. Pr. Inst. Masz. Przeply.; No. 54/55, 59-68(1971). (In German).

In an MHD channel flow, the electrical conductivity of a multicomponent plasma can be characterized by the components of a tensor, where (1) the Hall conductivities can be calculated for a weakly ionized plasma, (2) the ionic current is negligible as compared to the electronic current, and (3) the collision frequency of the electrons is velocity independent. The first two hypotheses may well match the situation in an MHD generator, but not the third one. The effect of the modification of hypothesis (3) is followed by calculation. A block scheme of the calculation is shown and it is concluded that the hypothesis of velocity-independent collision frequency leads to discrepancies that must not be overlooked. Extensive numerical (computational) results are presented. The results, however, may be interesting information for those who are working with MHD generators. (App. Mech. Rev.)

18100 PRESENT SITUATION AND THE PERSPECTIVES OF MHD GENERATOR RESEARCH AND DEVELOPMENT. Antal, K. G.; Bolla, I. F. Musz. Tud.; 46: No. 1-2, 149-166(1973). (In Hungarian).

The paper reviews the present situation of research on electrical power generation by magnetohydrodynamics (MHD). The prospective R and D concepts of the countries where MHD research is most intensive are analyzed, emphasizing the presently most advanced themes which can be realized in the near future: the open-cycle smoke gas generator power stations, including the ancillary equipment needed for their economic operation. In the light of the data presented at the 5th International MHD conference, the specific power station projects are compared. (auth)

18101 MAIN TRENDS IN MHD GENERATOR RESEARCH. Janos, B.; Karoly, S. Musz. Tud.; 46: No. 1-2, 11-35(1973). (In Hungarian).

The first MHD equipment having practical importance was described in 1935. More intensive research was started in 1956. At present the most advanced development work is carried out in the Soviet Union. The paper reviews the situation of the research on MHD generators with smoke gas, noble gas, and liquid metal working fluids and presents the basic relations current in the international literature. (auth)

18102 HIGH TEMPERATURE REGENERATIVE HEAT EXCHANGERS FOR OPEN CYCLE MHD POWER PLANT. I. Omori, T.; Imatake, T.; Matsubara, S.; Irino, M.; Marita, Y. (Mitsubishi Heavy Industries, Ltd., Tokyo). Mitsubishi Juko Giho; 10: No. 1, 115-131(Jan 1973). (In Japanese).

The MHD power plant is a high-efficiency, low-pollution energy system. One of the most important components of an open-cycle MHD power plant is a very high temperature air heater using MHD combustion gases containing both alkali and metal seedings and fuel impurities. Two types of regenerative heat exchangers have been developed; valve switching stationary generator with pebble beds and rotary regenerator with perforated bricks. These regenerators have now entered into the stage of practical application in various industrial fields as well as to MHD power plants. The performance and characteristics of the two systems are described. (auth)

18103 THERMIONIC GAS-PRESSURE-BONDED SHEATHED INSULATORS AND METHOD OF PRODUCING SAME. Weaver, C. V.; Ranken, W. A.; Lawton, R. G. (to United States Atomic Energy Commission). U. S. Patent 3,736,658. 5 Jun 1973. Filed date 12 Oct 1970. 8p.

The collector of a thermionic converter, an insulator, and a metal sheath for the insulator are directly gas-pressure-bonded together such that the trilayer thus formed is stress relieved and maintains good structural integrity during machining and during thermocycling caused by operation of the converter. The insulator is alumina and the collector and sheath consist either of niobium metal or Nb–1 wt.% Zr alloy. (7 figures) (Official Gazette)

18104 INVESTIGATION OF THE DISCHARGE STRUCTURE IN A NOBLE GAS ALKALI MHD GENERATOR PLASMA. Part I. Brederlow, G.; Witte, K. J.; Zinko, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 11: No. 8, 1065-1072(Aug 1973).

The discharge structures in a noble gas alkali MHD generator were investigated under stationary conditions by means of image converter pictures and probe measurements. The current concentrations already known from short-time discharges and referred to as streamers were observed. The nature of these streamers was investigated by considering the relationship between the streamers and the ionization instabilities usually present in noble gas MHD generators. The measurements showed that the streamers are directed parallel to the mean current direction and constitute regions of elevated current density in which ionization instabilities can develop. (auth)

18105 INVESTIGATION OF THE DISCHARGE STRUCTURE IN A RARE GAS ALKALI MHD GENERATOR PLASMA. Part II. Brederlow, G.; Witte, K. J. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 11: No. 8, 1072-1079(Aug 1973).

The aim of these experiments was to determine the causes of current concentrations, called streamers, that occur in rare gas alkali MHD generators and lead to a striated discharge structure. Similar current layers have been found theoretically under equivalent conditions. According to theory, the disturbances caused by the discontinuities in the boundary conditions (segmentation) propagate into the plasma along the current and field lines if the Hall parameter exceeds a critical value. Thus, a striated discharge structure forms in the generator duct in accordance with the electrode geometry. In order to determine whether the experimentally found striated discharge structures are identical with the theoretical structures, the influence of the electrode configuration on the discharge structures was investigated. The image converter pictures taken clearly demonstrate the relations existing between the striations and the electrodes, as predicted by the theory. They also show that the streamers only occur if the Hall parameter exceeds a critical value which coincides within the experimental accuracy with the theoretical one. The study also deals theoretically and experimentally with the question how the critical Hall parameter varies when N_2 is added. The calculations revealed that it is reduced compared with that in a pure rare gas alkali mixture. This reduction of the critical Hall parameter was experimentally confirmed. (auth)

18106 COMPARISON OF STRONTIUM-90 AND PLUTONIUM-238 MILLIWATT THERMOELECTRIC GENERATORS. Carney, H. C. (Gulf General Atomic Co., San Diego, CA). pp 143-169 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Interest in milliwatt radioisotope generators has expanded as a result of major performance improvements, and there is excellent potential for acceptance in many oceanographic and biomedical applications. The characteristics of ^{90}Sr and ^{238}Pu milliwatt thermoelectric generators are summarized based on current technology, and the results of future development on performance and design discussed. The effects of thermoelectric materials, thermal insulation, and shielding on size, weight, and performance are reviewed. The performance and design characteristics of several operational milliwatt generators recently developed at Gulf General Atomic are described. (auth)

18107 GIPSIE RADIOISOTOPIC GENERATOR FOR USE IN CARDIAC PACEMAKERS. Alais, M.; Etieve, B.; Stahl, A.; Thomas, P. (Compagnie Industrielle del Telecommunications Bruyeres-le-Chatel, France). pp 191-206 of Power from Radioisotopes. . Washington, DC; OECD Publications Center (1972). (In French).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

A long life thermoelectric radioisotopic power source was designed and constructed for the numerous electrical pacemakers now in medical use. The radioisotope is ^{238}Pu and thermocouples are in Bi_2Te_3. A description of the power source is given and the mechanical design is discussed. (auth)

18108 ISOTOPIC THERMOELECTRIC BATTERY FOR CARDIAC PACEMAKERS. Renner, T.; Rittmayer, G.; Falkenberg, D.; Grubmueller, G. (Siemens AG, Erlangen, Ger.). pp 207-216 of Power for Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The thermoelectric conversion system consists of thin-film thermocouples deposited by a flash-evaporation technique using a tape of polyimide as a substrate. These tapes are wound to produce coils. Two coiled tapes are combined with a spherical capsule containing ^{238}Pu as a heat source. Thermal measurements and calculations enable the optimization of the conversion system with respect to the desired power and voltage. Experimental data, such as delivered power, efficiency, and voltage are presented. (auth)

18109 THERMO-ELEMENTS FOR NUCLEAR BATTERIES SPECIALLY DESIGNED FOR CARDIAC STIMULATORS. Adler, K. (Baumgartner Freres SA, Grenchen, Switzerland; Ducommun, G.; Berger, W. pp 217-219 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

In addition to the volume constraints imposed when developing ^{238}Pu-fueled thermoelectric nuclear batteries for cardiac pacemakers, account should be taken of the requirements which are, on the one hand the absolute reliability of the device, the safety of the patient, the highest conversion efficiency, minimization of the contained radioactivity, and of cost. Such objectives can be met only by developing especially designed techniques. The development of two specific methods for obtaining satisfactory solutions are described. The first involves the evaporation of metal thermoelements and the second is a special process for preparing and attaching semiconductor doped thermoelements. (auth)

18110 MODEL OF A THERMOPHOTOVOLTAIC RADIONUCLIDE BATTERY. Robenhorst, H.; Tschulena, G. R. (Battelle–Institut eV, Frankfurt am Main). pp 241-252 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

A model of a thermophotovoltaic energy converter is discussed. Since the effective spectral range of a photoelectric element is generally small compared with the relatively large spectral range of the thermal radiation, the efficiency of such a system may be expected to be low. These difficulties can be avoided if a broadband photocell of a material with a graded energy gap is used and the emission from the radiator is confined with an edge filter to a narrow spectral region. By proper choice of the filter and the photosensitive material it is possible to ensure that the spectral curves of the radiator and the photocell largely overlap. The efficiencies which theoretically can be attained with such a system are indicated. First experimental results obtained on an (In,Ga)As photocell are reported. (auth)

18111 PRACTICAL LIMITS OF RADIOPHOTOVOLTAIC CONVERSION SYSTEMS. Schalch, D.; Scharmann, A. (Univ. Giessen, Ger.). pp 253-263 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Experiments aimed at proving the accuracy of theoretical predictions on power and efficiency limits of radiophotovoltaic devices are described. Different parameters determining conversion efficiency were investigated systematically: conversion efficiency of different phosphors, deterioration of different phosphors, optimal thickness of nuclide phosphor layer, optimal ^{147}Pm load on the phosphor, and efficiencies of different photocells. (auth)

18112 THERMAL ACCUMULATORS. de Cachard, M. D. (CEN, Grenoble, France). pp 265-277 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

A method for storing thermal energy, by means of heat which is absorbed or released during the melting or solidification of a body is described. The efficiency of the method depends on the choice of body to be melted, the thermal insulation used, and the heat transfer. Experimental data on the variables are presented. (auth)

18113 PRELIMINARY RESULTS OF A RADIATION EXPERIMENTAL CONVERTER. Mavroyannakis, E. G. (Democritus Nuclear Research Center, Athens). pp 279-305 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Experiments on the conversion of radiation energy into thermal energy are described, and preliminary results are reported. A brief description of the first converter built for experimental purposes and the measurements performed with this device are also given. (auth)

18114 MINIATURIZED ISOTOPIC BATTERIES. Adler, K.; Ducommun, G. (Baumgartner Freres SA, Grenchen, Switzerland). pp 307-309 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

A battery which uses the direct charge collection method to collect particles emitted by tritium in order to drive the resonant oscillation of a mechanical vibrator by electrostatic oscillation is described. This high-impedance composite system (10^{11} to 10^{12} Ω) operated at a high voltage (10^2 to 10^3 V), requires a very low current, hence very small quantities of radioactive material and does not need an electronic circuit. It can be applied directly to drive electronic wrist watches, and ensures an independent lifetime longer than 10 years. (auth)

18115 TRITIUM NUCLEAR CARDIAC PACEMAKER BATTERY. Gatt, F. C. (Australian Atomic Energy Commission, Sutherland). pp 325-338 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

A nuclear battery suitable for a cardiac pacemaker is described. The battery uses the radioisotope tritium and produces power via the electron voltaic effect. Details of the battery, its construction and some of the problems and solutions associated with the electron-voltaic diode and the form of the isotope are given. Radiation and toxicity levels of candidate isotopes are listed showing that tritium is more suitable for use in implantable nuclear power sources. The economic and technical disadvantages of tritium batteries over other batteries both nuclear and chemical are explored. (auth)

18116 DEVELOPMENT OF THERMIONIC RADIOISOTOPE BATTERIES. DeStreese, J. G. (McDonnell Douglas Corp., Richland, WA). pp 339-363 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The ISOMITE battery, a miniature thermionic converter heated by an integral radioisotope heat source, operates in a quasi-vacuum mode. The theory, construction, output, and life characteristics are reviewed. Thermionic batteries powered by promethia and plutonia have been constructed with 200 μW to 100 mW electric output power. Modules with a 1-W output have been operated in the laboratory using electric heaters. Conversion efficiencies exceeding 5% have been measured. Potential gains in conversion efficiency and the characteristics and size of 1 μW to 1 kW output devices are estimated. Energy conversion efficiencies exceeding 15% are foreseen. (auth)

18117 DEVELOPMENT OF AN ACTINIUM-FUELED THERMIONIC CONVERTER. Dumont, G. (Union Miniere, Brussels); Posin, M.; Baestsle, L.; Van Lierde, W.; Birnbreier, H.; Fischer, W.; Gammel, G. pp 365-384 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The generator is described in detail, giving data on the fuel, capsule, and the conversion system. The state of development is given including design characteristics and special topics, e.g., helium venting, materials compatibility, and mechanical behavior of the system. Performance data of the conversion system and life tests results of generator components are discussed. The combination with supplementary thermoelectric converters in this system is analyzed. (auth)

18118 DEVELOPMENT OF THE RADIOISOTOPIC THERMOELECTRIC GENERATOR TRISTAN. Merges, V. (Messerschmitt-Boelkow-Blohm GmbH, Munich). pp 385-396 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The energy source of TRISTAN consists of 45 kCi ^{90}Sr in the form of pressed $SrTiO_3$ pellets in a safety capsule. The partially cascaded energy converter operates in a temperature drop from 900°C to 50°C and produces 5.4 V at 4.5 A. The incorporated DC converter supplies 22 W(e) at 24 V to the feed-through. The corrosion-resistant housing with a lead shielding permits diving depths down to 10,000 m. The concept, development, active testing, and scope of application of TRISTAN are reviewed. (auth)

18119 RADIOISOTOPE FUELLED BATTERIES USING PLUTONIUM-238 AND STRONTIUM-90. Myatt, J.; Brown, M. H.; Neighbour, F.; Penn, A. W.; Poole, M. J.; Ryden, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 397-423 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The development at the Atomic Energy Research Establishment, Harwell of radioisotope-powered thermoelectric generators covering the power range 200 μW(e) to 20 W(e) is described. The work has involved the development of two main types of generator. For power levels below 10 mW(e) ^{238}Pu nitride is used as the fuel but as the level is increased above this it has been replaced by ^{90}Sr titanate. (auth)

18120 POWER GENERATOR USING A RADIOISOTOPIC SOURCE WITH THERMODYNAMIC CONVERSION: GICODYNE 400. Cavoret, J. (CEN, Grenoble, France); Cohen, M.; Lavigne, P.; Teytu, A. pp 425-443 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In French).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Gicodyne 400 is a power generator with a ^{60}Co radioisotopic source delivering an electrical power of 100 W. The heat is converted into electricity by a dynamic system consisting of 2 cascade organic vapor turbines. Each turbine drives a generator. Safe operation was a main feature of the design. (auth)

18121 COMBINATION OF A RADIOISOTOPIC HEAT SOURCE AND A STIRLING CYCLE CONVERSION SYSTEM. Hermans, M. L. (Philips Research Labs., Eindhoven, Netherlands); Uhlemann, H.; Spigt, C. L. pp 445-466 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

Radioisotopes can be used for long lasting unattended thermal energy production in a range up to about 10 kW. Because of cost reasons the conversion of the produced thermal energy into mechanical or electrical energy must be done with a high rate of efficiency. For this conversion a Stirling engine can be used working with an efficiency of about 35 to 40%. From its configuration the Stirling engine is very well suited to convert thermal energy into mechanical or electrical energy. The system consisting of a radioisotope heat source, heat transport system, and Stirling engine is discussed, and the development stage of the various components described. Furthermore various fields of applications will be indicated. (auth)

18122 STIRLING ENGINES FOR ISOTOPE POWER GENERATION. Walker, G. (Univ. of Calgary, Alberta). pp 467-496 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Stirling engines are heat engines that appear well suited for application as the thermal converter in isotope-fueled systems for electric power generation and fluid pumping. At power levels greater than about 10 W it is likely they can be more efficient than other systems with increasingly significant advantages at higher power levels. They have the potential for long-term reliable operation and there is no upper limit to the power level. General considerations for isotope thermal conversion systems with particular reference to Stirling engines and reports on one prototype engine development program including advanced research topics are summarized. (auth)

18123 POWER SUPPLY FOR AN AUTOMATIC MEASURING STATION AT TERRE ADELIE USING AN ISOTOPIC GENERATOR. Bercy, C. (Groupe de Recherches Ionospheriques, Saint-Maur, France); Vigneron, J.; Etieve, B.; Thomas, P.; Boutaine, J. pp 501-516 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In French).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

In studies of the magnetosphere near the magnetic south pole, a geophysical experiment was undertaken in order to get a better knowledge of the very low frequency emissions (VLF) associated with the high-energy particles in the polar area. Because of the high sensitivity of sensors used the automatic station was located 5 km from the base in order to eliminate the industrial noise emitted by the base. The station is powered by a radioisotope thermoelectric generator (ISOTAAF 1). The complete experiment, method, and apparatus are described. (auth)

18124 APPLICATION OF RADIOISOTOPIC POWER GENERATORS IN OCEANOGRAPHY AND MARINE TECHNOLOGY. Victor, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). pp 517-523 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Autonomous energy sources are needed in oceanographic buoys, unmanned and manned submersibles, underwater habitats, and in systems for the offshore exploitation of oil, gas and minerals. The power and energy demand of the various equipment is specified. Criteria for the competitiveness of radioisotopic power generators coupled with static and dynamic converters are presented. (auth)

18125 RESULTS OF EXPERIMENTS WITH THREE THERMOELECTRIC GENERATORS USING RADIOISOTOPES ON OFFSHORE OIL RIGS. Freund, J. P. (Compagnie Francaise des Petroles, Paris). pp 525-532 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In French).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

In a program for testing self-contained power sources capable of supplying power for submerged oil rig installations, three thermoelectric generators using isotopic fuels as heat sources were tested. These three generators differed as to the thermoelectric material used and in: power delivered (100 mW to 25 W); internal design of the generators; and type of material used in the generator structure. The experimental techniques, the adjustments made during the test runs, the results obtained, and the expected reliability are described. The time behavior of thermoelectric generators is compared, the resistance/strength aspect in the environment of the structural material is examined, and problems of correct adjustment and selection of auxiliary components are discussed. (auth)

18126 ITALIAN ACTIVITY OF RADIOISOTOPE-POWERED THERMOELECTRIC GENERATORS FOR UNDERWATER APPLICATION. Germano, G.; Merzagora, N.; Serbassi, S. (CNEN, Rome). pp 533-543 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

A 5 W(e) thermoelectric generator designed in collaboration with CNEN and ENI for underwater applications to a depth of 200 m is discussed. Particular care has been taken in improving some critical aspects of such generators including: the development of a compact conversion system with high thermal and electrical stability; the optimization of thermal flux from the isotopic source to the cold sink; and the design of the pressure vessel in accordance with the IAEA transport regulations and withstanding long-term marine corrosion. The RTG is intended for supplying subsea wellhead automatic equipment. (auth)

18127 DESCRIPTION OF THE TRANSIT RTG. Bradshaw, G. B. (Gulf General Atomic, San Diego, CA); Hagis, W.; Lurie, H.; Postula, F. D. pp 545-569 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The first five-year-lifetime space radioisotope thermoelectric generator was developed for the U. S. Navy's TRANSIT Navigational Satellite under contract to the USAEC. The RTG is designed to produce a minimum of 30-W end-of-mission power using lightweight, lead telluride thermoelectric panels. These panels operate at low hot side temperatures (400°C) in a vacuum environment, thereby providing increased reliability over systems requiring a hermetically sealed cover gas to inhibit thermoelectric material sublimation. An 850 W(t) ^{238}Pu heat source, which is designed to meet aerospace nuclear safety requirements of intact reentry and intact impact capabilities, is used to provide the required thermal power. The fuel capsule is a refractory metal layered configuration which uses a graphite reentry heat shield. (auth)

18128 TESTING OF THE IMPROVED SNAP 19-PRIMARY POWER FOR ADVANCED SPACE MISSIONS. Dick, P. J. (Teledyne Isotopes, Timonium, MD). pp 571-590 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The first electrically heated engineering prototype SNAP 19 High Performance Generator (HPG) has been powered up with test data showing above nominal design performance and achievement of basic program development objectives. The HPG unit produces 69 W(e) at a specific power of 1.8 W(e)/lb and overall system efficiency of 6.7%. These significant performance improvements in the basic SNAP 19 technology were obtained through optimization of structural housing design, reduction of thermoelectric heat rejection complexity, and volumetric efficiency resulting from power growth. As evidenced by nearly 6000 h of continuing HPG life test through April 1972, supporting flight data from the four SNAP 19 RTG units now powering the first spacecraft destined for Jupiter (Pioneer 10), and other ground test generators, long term electrical output for five years or more can be predicted. (auth)

18129 REVIEW OF RADIOISOTOPE POWER SOURCE DEVELOPMENT AT ATOMIC ENERGY OF CANADA LIMITED. Round, K. J. (Atomic Energy of Canada Ltd., Ottawa). pp 591-612 of

Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The radioisotope power program at AECL includes the development of multiwatt systems fueled with ^{60}Co, and small nuclear batteries fueled with ^{147}Pm and tritium. Thermoelectric generators with outputs from 2 W(e) to 35 W(e) are described. Current development programs include dynamic energy conversion systems for output powers in excess of 50 W(e), and a variety of beta voltaic nuclear battery systems. (auth)

18130 REVIEW OF ISOTOPE GENERATOR DEVELOPMENTS 1966–72 IN THE UNITED KINGDOM. Wiblin, E. R. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 613-622 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The developments which have taken place in the field of power generation from radioactive isotopes since 1966 are reviewed from the United Kingdom's point of view. A brief description is given of the technical developments which have been made, and the experience in field evaluation of prototype generators made in Harwell is discussed. Other related power systems and particularly miniature thermoelectric batteries currently being developed for use in implantable devices are mentioned. (auth)

18131 FUTURE OF RADIOISOTOPIC POWER APPLICATION (EXCLUDING MEDICAL APPLICATIONS). pp 625-637 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In English and German).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

A panel discussion by 14 representatives of 7 countries on the development of radioisotope-fueled power systems for non-medical uses is reported verbatim. Programs which have been undertaken in the various countries to develop radioisotope-fueled thermoelectric and Stirling engine conversion systems for remote terrestrial and space use are described. The effort and cost of future developments are discussed. (LCL)

18132 MICRO-BATTERIES IN MEDICAL PRACTICE. Senn, A. (Univ., Bern). pp 643-646 of Power from Radioisotopes. OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Seven possible modes of application for micro-batteries including radioisotope-fueled batteries, in medical practice are briefly described. These uses are: pacemakers; assisted circulation; stimulation of the glomus caroticum in angina pectoris; sphincter stimulation; stimulation of the phrenic nerve in paralysis of the diaphragm; prosthetic fitting of amputees; and hearing aids. (LCL)

18133 IN-PHANTOM DOSIMETRY FOR A NUCLEAR HEART PACEMAKER. Gibson, J. A. B.; Marshall, M.; Docherty, J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 647-667 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The use of ^{238}Pu in artificial heart pacemakers necessitated a full investigation of the radiation dose to the surrounding tissue and body organs in order to estimate the possible risks from radiation. Measurements in a homogeneous tissue equivalent solution and in bone and artificial lung confirmed that the dose could be predicted from the spectrum of γ-rays at the surface of the pacemaker. Corresponding measurements with neutrons were not possible but an approximate estimate of the neutron dose rate has been made. The total dose at the surface of the pacemaker will be 550 rem in the 10 y following the separation of the plutonium. The average dose to the whole body will be 3.5 rem in 10 y for a pacemaker under the left arm. Location of the pacemaker at a different place in the body will reduce this dose, e.g., the equivalent dose for the pacemaker on the right breast will be 2.3 rem in 10 y. (auth)

18134 STUDIES OF NUCLEAR CARDIAC PACEMAKERS. Carleson, G. (Aktiebolaget Atomenergi, Studsvik, Sweden); Svansson, L.; Thoren, A. pp 669-685 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Gamma spectra and dose rates were recorded for prototypes of ^{238}Pu power sources and complete battery units in different shielding configurations. Registered peaks were identified and used to determine contaminants which give significant dose contributions. Safety problems related to the adoption of basic standards for the manufacture and application of nuclear pacemakers were investigated, as for example the hazards presented by inadvertent cremation and the effects of gamma sterilization. A nuclear prototype with Elema–Schoenander electronics was implanted in a dog. Experience gained with this device will be discussed and related to improvements which are in progress preliminary to implantation in human beings. (auth)

18135 CLINICAL APPLICATIONS OF A RADIOISOTOPIC CARDIAC PACEMAKER. Laurens, P.; Piwnica, A.; Reidemeister, C. (Hospital Broussais, Paris). pp 687-698 of Power from Radiosotopes. Washington, DC; OECD Publications Center (1972). (In French).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The first human implantation of a cardiac pacemaker powered by ^{238}Pu took place on April 27, 1970 at the Hospital Broussais in Paris. Since then and until the beginning of 1972, 28 clinical applications have taken place in four countries. The patients had a permanent low pulse and most of them were affected by fainting. The patients treated returned to a normal, active life. Their average age at the time of implantation was 42.5 years. The long-term reliability of this pacemaker, based on calculations, experiments and results of clinical applications is greater than 10 years. (auth)

18136 DEVELOPMENT PROSPECTS IN FRANCE FOR THE ARTIFICIAL HEART: METHODOLOGICAL APPROACH RELATED TO THE DELPHI TECHNIQUE. Derian, J. C. (CEA, Paris); Berger, R. pp 699-712 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In French).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The artificial heart is still no more than a research project involving a number of uncertainties; an attempt to limit them has been made by obtaining the opinions of some hundred specialists concerned. From this confrontation which used an iterative process of the Delphi type it was possible to reach a consensus on the feasibility of, and the volume of the potential need for, artificial hearts in France. The data from this enquiry, processed by factorial analysis, also made it possible to reach a certain number of conclusions which give some indication of the validity of the result obtained. (auth)

18137 U. S. ATOMIC ENERGY COMMISSION NUCLEAR-POWERED ARTIFICIAL HEART PROGRAM. Mott, W. E.; Cole, D. W.; Holman, W. S. (Atomic Energy Commission, Washington, DC). pp 713-730 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The U. S. Atomic Energy Commission is currently evaluating whether a totally implantable nuclear-powered artificial heart having a lifetime of 10 y can be built within the constraints that must be imposed on weight, volume, shape, isotope inventory, and reliability. To provide the information necessary, research and development projects are underway on the medical grade ^{238}Pu fuel and its encapsulation for long-term containment under all credible accidents; on a highly reliable, long-life thermal engine for conversion of the radioisotopic heat to mechanical blood pumping power; and on the radiobiological implications of large-scale heat source implantation including both the radiation exposure to the artificial heart recipient and to the population-at-large. (auth)

18138 EXPERIENCE WITH IMPLANTED RADIOISOTOPE-FUELED ARTIFICIAL HEARTS. Harmison, L. T. (National Heart and Lung Inst., Bethesda, MD); Huffman, F. N.; Martini, W. R.; Rudnicki, M. I. pp 731-761 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The first operating nuclear powered artificial heart system is described. Data are presented on engineering performance, radiation environment, and animal tests with a 50 W ^{238}Pu source. In the diseased heart, the muscle of the heart becomes too weak to pump all the blood. Assisting the heart in this vital task is being studied in experimental animals. The biological problems of employing a suitable blood pump to beneficially affect an animal are being solved. Many of these blood pump tests require a large relay rack full of equipment connected to the electric utility to apply the required power. When this development is applied, serious problems will develop because the patient will be tethered to a cumbersome power source. One facet of this effort is to develop implantable power sources and controls powered by a radioisotope. A capsule has been developed for minimum radiation exposure and 5 y safe life. One power source and control employs a helium-filled isotope-heated Stirling engine to pump a hydraulic fluid which in turn is used to operate the blood pump through automatic hydraulic control. The second radioisotope powered modified

Stirling engine system with external regeneration employs a complete pneumatic drive and control system for operating a totally implantable heart assist system. The third nuclear-powered heart system employs a condensible fluid filled isotope heated Rankine–Stirling engine to power the blood pump directly. A thermoelectric generator operates automatic electronic controls to switch the pressure available from the engine on and off using a bistable solenoid or torque motor. These three systems have been developed to the point of having a finished, radioisotope-fueled artificial heart completely implanted in a calf who is fully awake and free to move. (auth)

18139 IMPLANTABLE DEVICES AND THEIR ENERGY NEEDS. Wallner, F. (Freie Univ., Berlin). pp 763-772 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The aim of artificial organs' research nowadays is the partial or total substitution of irreversibly damaged internal organs for the lifetime of the patient. Artificial implants must: maintain the desired function under the particular environment in the body; limit the body's unwanted reactions or avoid them; and contain the energy supply necessary for their operation. Several implantable devices are mentioned and their estimated energy consumption is noted, no matter if they are already realized or only projected. (auth)

18140 ADVANCES IN THE SAFETY OF SPACE NUCLEAR POWER SYSTEMS. Dix, G. P. (Atomic Energy Commission, Washington, DC). pp 779-797 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The operating experience and advances in the safety of space nuclear power systems fueled with ^{238}Pu are reviewed. The operational safety experience with eight NASA launches of spacecraft powered with nuclear energy since 1968 including two Nimbus weather satellites, the Apollo 12, 13, 14, 15, and 16 lunar landing missions, and the Pioneer 10 Jupiter mission is discussed. Several new concepts of modular heat sources are also presented. (auth)

18141 LEAK TESTING OF TRITIUM-FUELLED EXPERIMENTAL BATTERIES. Angoso, M. (Junta de Energia Nuclear, Madrid); Grau, A.; Dominquez, G.; Pintado, J. M.; Perez del Notario, P. pp 799-804 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

Tritium released by the device and a hydrogen carrier is converted into water in a CuO bed; water activity is finally measured by liquid scintillation spectrometry. Leak rates as low as 0.2 mCi/y have been actually measured although much lower activities can be determined. The procedure has been applied with quite satisfactory results to experimental batteries as well as to bare tritium targets. (auth)

18142 SAFETY ASPECTS OF INCORPORATED RADIATION SOURCES. Hunzinger, W. (Swiss Working Party on the Safety of Nuclear Batteries, Bern). pp 805-808 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519--.

The use of radioactive material as a power source implanted in the human body, such as ^{238}Pu batteries to drive cardiac pacemakers, becomes more and more important. In most cases the amount of radioactive material present in the body is considerable and the nuclide hazardous. Bearers of isotopic batteries are not necessarily old people bound to hospital beds. They include all ages and persons in their full professional activity. A bearer of an isotopic battery can hardly be confined to a controlled zone, the establishment of which is a well-known principle of control in radiation protection, nor can he be treated like a consignment of radioactive material and be subject to the well-established test procedures for these packages. The safety principles of isotopic sources implanted in a freely moving human are outlined. They focus on the exposure of other people to penetrating radiation, on partial loss of the radioactive material, i.e., exposure to contamination, and on the total loss of control over the source. (auth)

18143 ACCIDENT ANALYSES. Freke, A. M. (National Radiological Protection Board, Harwell, Eng.). pp 809-813 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

Before the introduction into use of any new device powered by a radioisotopic source, an accident analysis is required. The analysis is intended to identify those situations in which the device could be subjected to stresses greater than those expected under normal conditions of use. The analysis should provide the information to determine the requirements necessary to maintain the integrity of containment of radioactivity, in terms of time and resistance to stress, under all foreseeable circumstances. An accident analysis is not intended to determine prototype tests for a device but it does indicate the types of test necessary and the criteria on which to base such tests. (auth)

18144 WHAT HAPPENS TO A NUCLEAR MEDICAL DEVICE AND HOW TO PERFORM A SAFETY ANALYSIS. Karb, E.; Sepold, L.; Weinlaender, W. (Gesellschaft fuer Kernforschung MbH, Karlsruhe, Ger.). pp 815-826 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

The use of nuclear sources of energy for medical applications calls for new safety evaluations which are different from those methods used in reactor safety analysis. Starting with the differences between reactor and nuclear medical systems a concept is developed for the implementation of a safety analysis, which should consist of three parts: an accident analysis, a stability analysis, and a damage analysis. All three together finally determine the risk to which society is exposed. Based on these considerations the three parts are described in detail. Finally, the feasibility of the safety analysis is discussed, while the question of the acceptable risk is left open. (auth)

18145 MECHANICAL RESISTIVITY OF THE FUEL CAPSULE OF RADIOISOTOPIC-POWERED CARDIAC PACEMAKERS AGAINST BULLETS OF FIREARMS. Flakus, F. N. (Technische Univ., Munich); Zoebel, K. F. pp 849-857 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

A firearms test on French radioisotope-powered pacemakers shows that their fuel capsules withstand bullets with kinetic energies up to 100 J. A bullet fired by a centerfire rifle, with a kinetic energy of nearly 4000 J destroyed the capsule completely. (auth)

18146 BIOLOGICAL DOSE AROUND A CARDIAC PACEMAKER. Devillers, C.; Hot, M. (CEA, Fontenay-aux-Roses, France). pp 859-873 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In French).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

The results of a theoretical study on the absorbed doses in the biological tissue near a pacemaker fueled with a 155 mg ^{238}Pu source are presented. An amount of 0.5 ppM of ^{236}Pu is taken into account when evaluating the gamma source. The gamma attenuation through the pacemaker shields has been calculated by the code MERCURE 3. The diffusion of spontaneous fission neutrons was treated with the Monte Carlo code TRIPOLI. Calculated doses are in good agreement with some available measurements. (auth)

18147 COMPARISON OF PLUTONIUM AND PROMETHIUM CONTAINMENT FOR MEDICAL APPLICATIONS. Warner, E. E. (McDonnell Douglas Corp., Richland, WA). pp 875-891 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

Safety criteria developed for plutonium may require modification for beta-emitting isotopes such as promethium because of the absence of helium generation, differences in radiation characteristics, and relative biological hazards. Design approaches for plutonium capsules are compared with those for a promethium-fueled nuclear battery illustrating techniques which meet the critical cremation and mechanical loads. Safety test results are presented to demonstrate that both plutonium and promethium devices are suitable for widespread implantable medical applications. (auth)

18148 LEGAL AND REGULATORY QUESTIONS CONCERNING USES OF RADIOISOTOPIC BATTERIES. Ritchie, K. J. S. (OECD, Nuclear Energy Agency, Paris). pp 907-913 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

In connection with new applications of radioisotope-powered batteries which are now being developed it is important not to ignore the legal and administrative problems. The use of cardiac pacemakers powered in this way involves consideration of questions concerning control procedures, recovery after death, and unrestricted travel of bearers. Other new and interesting uses of isotopic batteries are in course of development and international

cooperation is desirable so as to control but not hinder these developments. (auth)

18149 USE OF ISOTOPIC POWER GENERATORS: REGULATORY ASPECTS. Michon, G. (Commission Interministerielle des Radioelements Artificiels, Gif-sur-Yvette, France). pp 915-923 of Power from Radioisotopes. Washington, DC, OECD Publications Center (1972). (In French).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720510-.

The use of isotopic power generators raises a series of problems of a regulatory nature, connected with the protection of the population. These problems are examined for generators classified into three categories: generators for terrestrial or marine applications for which international recommendations already exist; generators intended for medical purposes; and miniature generators requiring stringent restrictions. (auth)

18150 ADMINISTRATIVE ASPECTS OF THE USE OF NUCLEAR POWERED HEART PACEMAKERS. Gregory, C. (Dept. of Health and Social Security, London). pp 925-929 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

A number of factors which have to be considered before accepting nuclear-powered pacemakers for general use in a comprehensive National Health Service are discussed. These are medical acceptability based on proved performance and safety to the patient. Economic factors, when considering that any new therapeutic equipment must be made available to all patients, unit costs, surgical and ancillary costs and in-patient costs, etc., have to be balanced against expected improvements in patient treatment. Control of patient movements and recovery of pacemakers pose medical-legal problems which are difficult to solve. Problems are posed solutions to which have not been found, and only when the full advantages to be gained from such developments are fully realized will it be possible to press for legal amendments. Together with the immediate difficulties outlined above there is a need to ensure continuing supplies of equipment once its use has been sanctioned for the general service. (auth)

18151 USE OF RADIOISOTOPIC-POWERED CARDIAC PACEMAKERS: LEGAL AND ADMINISTRATIVE PROBLEMS IN ITALIAN LEGISLATION. Failla, L.; Nocera, F. (CNEN, Rome). pp 931-941 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In French).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

Nuclear-powered cardiac pacemakers have been developed for some years in Italy. As the practical application of such pacemakers is planned for the not too distant future, this requires regulations at national level concerning the protection of the public, especially if a patient were to die while bearing a radioactive source in view of the very long life of the radioisotope used. It is concluded that, given the status of Italian legislation on radiation protection in force, pacemakers require a more specific and comprehensive legal regime, based on the OECD Nuclear Energy Agency's recommendations which should soon be finalized. (auth)

18152 RADIOISOTOPIC POWER APPLICATIONS IN MEDICINE (WITH PARTICULAR REFERENCE TO THE FUTURE PROSPECTS OF CIRCULATORY SUPPORT SYSTEMS). pp 943-961 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972). (In English and French).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

A panel discussion of 10 representatives of 5 countries on the feasibility, safety, and cost of using radioisotope-fueled power systems for circulatory support systems is reported verbatim. Research programs in the countries represented on the development of radioisotope-powered mechanical hearts are discussed. (LCL).

Facilities and Equipment

Refer also to abstracts 18466, 18660, 20341, and 20643.

18153 (LA-5208-MS) PHENOMENA ASSOCIATED WITH THE PROCESS OF ROCK MELTING. Application to the Subterrene System. Krupka, M. C. (Los Alamos Scientific Lab., N. Mex.). Feb 1973. Contract W-7405-eng-36. 10p. Dep. NTIS $4.00.

Fundamental rock melting and associated phenomena, important to the development of a rock-melting excavation system, are described briefly. For most rocks, their multicomponent chemical system results in relatively low-temperature ranges, irrespective of type or classification. High-pressure injection of fluxing or mineralizing agents is considered as a technological assist in lowering these melting-temperature ranges. Increased pressure is shown to increase the melting temperature of silicate rocks, but the pressure will assist in the melting of some rock types such as limestone. The energy required to melt rock, as determined by their specific heat and heat of fusion, remains within reasonably narrow limits, which introduces a degree of insensitivity to variations in the type of rock conglomerate being penetrated by melting. Corrosion phenomena for specific refractory materials of the rock-melting penetrator systems are related to both thermodynamic and kinetic factors, and the rock-glass hole linings produced are briefly described. (auth)

18154 (LA-UR-73-815) TEMPERATURE CONTROL OF IRRADIATION EXPERIMENTS WITH GAS-CONTROLLED HEAT PIPES. Deverall, J. E.; Watson, H. E. (Los Alamos Scientific Lab., N. Mex.; Naval Research Lab., Washington, D. C.). [nd]. 12p. (CONF-730910-8). Dep. NTIS $3.00.

From international conference on irradiation experimentation in fast reactors; Jackson Hole, Wyoming, USA (10 Sep 1973).

One major problem of irradiation experiments is establishing a desired, constant test specimen temperature. It is not possible to instrument most test capsules so that specimen temperatures are not known. Also, isothermal conditions do not exist over the specimen section and the radiation input flux varies with time. The gas-controlled heat pipe has the capability of producing a variable heat-rejection system which can maintain a relatively constant, isothermal temperature with variations of heat input. A heat pipe incorporated into a test capsule can establish and maintain an isothermal specimen temperature with large variations of radiation input flux. (auth)

18155 (MHSMP-73-38) COMPRESSED GAS CYLINDER DRYING APPARATUS. Pennington, J. B. (Mason and Hanger Silas Mason Co., Inc., Amarillo, Tex.). 19 Jun 1973. 11p. Dep. NTIS $3.00.

Due to the extremely low humidity required in atomic weapon programs, and the inability to commercially purchase bottled air dry enough to meet the requirements, it was necessary for the plant to produce dry air and bottle it in their own cylinders. Even though extremely dry air was produced and bottled, it still was too wet due to moisture on the inside walls of the cylinders. An apparatus designed for drying the cylinders is described. (TFD)

18156 EQUIPMENT FOR THE IRRADIATION OF MICROORGANISMS IN SUSPENSION. Meissner, J. (Medizinische Akademie Luebeck, Ger.). Dennin, R. (Inst. fuer Strahlenforschung). G-I-T (Glass-Instrum.-Tech.) Fachz. Lab.; 17: No. 4, 339-341(1973). (In German).

Equipment is described for the irradiation of microorganisms in suspension under defined conditions of gas and temperature. The equipment consists of plexiglass segments, with the temperature being maintained constant by means of flowing water. It can easily be kept sterile and is put into an irradiation box. (GE)

Heat Transfer and Fluid Flow

Refer also to abstracts 20227, 20543, 20575, 20586, 20619, 20620, 20640, 20646, and 20650.

18157 (AECL-4516) PROCESS OF REWETTING A HOT SURFACE BY A FALLING LIQUID FILM. Thompson, T. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jun 1973. 24p. Dep. NTIS (U.S. Sales Only) $3.25. AECL $0.50.

A two-dimensional transient heat conduction model for the rewetting of a hot surface by a falling liquid film is used to predict the effects of wall thickness, thermal conductivity, volumetric heat capacity, and power generation on the rewetting rate. The model predicts that only a certain wall thickness takes part in the rewetting process, which is one of conducting heat from the dry to the wet region and removal of this heat in a narrow high-heat-flux zone. The critical thickness beyond which the rewetting rate is independent of wall thickness depends on wall thickness thermal conductivity, dry-region surface temperature, and environmental pressure. For practical purposes the critical thickness for materials with a thermal conductivity of about 10 Btu/h.ft°F, such as stainless steel or Zircaloy, can be considered to be 0.020 in. for rewetting in a steam environment in the pressure range of 100 to 1000 psia when the dry-region surface temperature is 300 to 500°F above the appropriate saturation value. The rewetting rate is predicted to increase with increasing thermal conductivity, but the increase is small if the wall thickness is greater than the critical wall thicknesses for the thermal conductivities considered. The

rewetting rate is inversely proportional to volumetric heat capacity. For a given dry-region surface temperature, the rewetting rate is nearly independent of the individual values of heat flux and dry-region heat transfer coefficient. Furthermore if the wall thickness is greater than the critical thickness, the rewetting rate is predicted to be the same for direct or indirect heating. Experimental results reported in the literature are interpreted in terms of the model, extrapolation is made to reactor spray-emergency-cooling conditions, and the requirements for future experiments are stated. (auth)

18158 (AEEW-M-1027) QUENCHING OF A HEATED ZIRCALOY SURFACE BY A FILM OF WATER IN A STEAM ENVIRONMENT AT PRESSURES UP TO 53 BAR. Elliott, D. F.; Rose, P. W. (Atomic Energy Establishment, Winfrith (England)). Aug 1971. 29p. Dep. NTIS (U.S. Sales Only) $3.50.

A series of experiments designed to measure the rate of propagation of a rewetting water film down a vertical heated Zircaloy surface are described. The experiments were carried out in a steam environment covering a range of water flowrates and for pressures from 1 to 53 bar. The results of the series of tests are discussed and are compared with data from previous experiments with quenching of stainless steel and Inconel surfaces. The comparison shows that the change to Zircaloy resulted in a considerable increase in the rewetting rates. The observations made previously in respect of stainless steel and Inconel, that the rewetting rate varied with the surface temperatures and with ambient pressure but was independent of spray cooling water flow rate, were shown to be valid for quenching Zircaloy surfaces. A correlation is given for the calculation of the rewetting rate in terms of surface temperature and ambient pressure. (auth)

18159 (SGAE-2117) STUDIES ON HEAT TRANSFER. 6. Progress Report, 1972. Schmidl, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.M.B.H., Seibersdorf). Apr 1973. 83p. (In German). Dep. NTIS (U. S. Sales Only) $6.25.

Using the Navier-Stokes and energy equations, the distribution of velocity and temperature in a tube with turbulent flow can be found. In addition, with the Newton's law concerning the heat transfer, a general law is derived. Of some importance in these equations is the eddy diffusivity for heat and momentum transfer. In particular, the first coefficient is expressed in the literature in very different numbers. Using the general law above and the well known empirical Nu- or St-numbers, the eddy diffusivity for heat transfer can be found as a function of Re and Pr numbers. (auth)

18160 USE OF A NEUTRON GENERATOR FOR INVESTIGATING LIQUID AND GAS FLOWS. Akerman, K. (Isotopen Technik, Duesseldorf, Ger.); Guizerix, J.; Margita, R.; Santos Cottin, M. Atomwirt., Atomtech.; 18: No. 6, 300-306(1973). (In German).

The feasibility of labeling liquid flows (Na_2O_3 aqueous solutions, $BaCl_2 \times 2H_2O$, water) and gas flows (air) by means of short-term on-line irradiation with a neutron flux produced by a D-T neutron generator has been confirmed. By choosing the appropriate irradiation time and time interval between irradiation and measurement and by discriminating suitable energy ranges, it is possible to measure only the activity of predetermined elements of interest. Thus Ba and Na in aqueous salt solution and oxygen in air and water could be activated and measured. A pulsed irradiation during 0.2 to 3s is sufficient to produce a measurable activity. Multiple irradiation with summation of the pulses counted during measurement leads to very good results and to a leveling of the statistical measuring variations. Thus good activity-time diagrams are obtained with the total irradiation time being rather short. (GE)

18161 HEAT AND FLUID FLOW IN STEAM AND GAS TURBINE PLANT. Conference Held at Coventry, England, April 3, 1973. London; Institution of Mechanical Engineers (1973). 287p.

Thirty four papers were presented, covering theoretical and experimental aspects of steam and gas turbines and compressors, turbine design and performance, energy losses in turbines, erosion and other studies of turbine blades, fluid flow studies, viscous flow, turbulent flow, two-phase flow, flowmeters, cavitation, heat transfer, studies of water droplets in wet steam, and fog cooling. (UK)

18162 PREDICTION OF BURNOUT POWER WITH FREON UP TO THE CRITICAL PRESSURE. Cumo, M.; Ferrari, G.; Urbani, G. (CNEN, Casaccia, Italy). Termotecnica (Milan); 27: No. 5, 269-274(May 1973).

Freon coolants, which have a widespread application in thermal-hydraulic plants, have been used recently to scale two-phase water flow problems, reducing considerably the power input and the test pressure. This successful application encourages the use of freons in research on basic two-phase flow parameters, such as the burnout thermal power. The adoption of a well known burnout correlation, the CISE correlation, slightly modified to predict the burnout powers in freon at every pressure up to the critical value is proposed. Original sets of data enable the use of this correlation with a narrow margin of error. (auth)

18163 MEASUREMENT OF PROPAGATION VELOCITIES OF PRESSURE AND VOID BY CROSS-CORRELATION OF FLUCTUATIONS IN NITROGEN–WATER FLOW. Miyazaki, K.; Isogai, K.; Fujii-e, Y.; Suita, T. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 10: No. 5, 323-325(May 1973).

18164 FRICTIONAL PRESSURE DROP FOR NAK–N_2 TWO-PHASE FLOW IN A RECTANGULAR CROSS SECTION CHANNEL OF LARGE ASPECT RATIO. Tanatugu, N.; Fujii-e, Y.; Suita, T. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 10: No. 4, 219-226(Apr 1973).

Frictional pressure drop in an isothermal liquid metal-gas two-phase flow through a rectangular channel with large width-to-height ratio is treated semiempirically for a NaK–N_2 two-phase flow system. The frictional pressure drop in the two-phase flow is compared with the following two reference values: (1) the frictional pressure drop in the liquid flowing alone in single phase with the same velocity as that of the liquid in the two-phase mixture, and (2) the frictional pressure drop in the liquid flowing alone in single phase with the same mass flow rate as that of the liquid in the two-phase mixture. The comparison with the former reference value is necessary for the prediction of friction loss in a liquid metal MHD generator channel whose medium would be a two-phase mixture. The semiempirical analysis was performed assuming the two-phase mixture to be a continuous medium with its properties, e.g., viscosity and density, defined by void fraction and the velocity determined by the total mass flow rate. In the region of low slip and density ratio ρ_g/ρ_l, the frictional pressure drop in the two-phase flow appeared to be smaller than that due to the liquid flowing alone with the same velocity as that of the liquid in the two-phase flow. The experiments were undertaken with the NaK–N_2 two-phase mixture flowing through a rectangular channel (4×60 mm^2). Data were taken over the following parameter range: NaK velocity: 5 ~ 30 m/s, void fraction: 0 ~ 70%, density ratio: 0.006 ~ 0.013, and quality: 0.07 ~ 1.10%. (auth)

18165 IMPROVEMENTS TO TUBULAR CORROSION-RESISTANT HEAT EXCHANGERS. (to Societe Babcock-Atlantique). French Patent 2,133,518. 16 Apr 1971. 8p. (In French).

Certain tube and tubular plate heat exchangers are made of materials susceptible to corrosion from one or other of the two circulating fluids. In such heat exchangers the base metal, e.g., steel is protected by a corrosion-resistant metal which is difficult to fuse weld to the base metal. This difficulty arises because of the production of fragile intermetallic or other type components. An attempt is made to resolve the problem. A tubular plate heat exchanger is proposed. One of the faces of this heat exchanger is provided with a protective corrosion-resistant metal plate, the other face also being provided with a metal plate. The two plates are joined by corrosion-resistant metal sleeves fitted into the holes in the tubular plate and assembled by welding. These sleeves are made of a metal which can be fuse welded to both plates, and act as hollow rivets holding them together. In addition these sleeves protect the base metal of the tubular plate in the holes through which the tubes pass and also constitute the joining elements suitable for the passage of corrosion-resistant tubes, the latter being fuse welded to the sleeving. (FR)

18166 SHOCK-LOSSES WITHIN CHANNEL FLOW. Markfort, D. (INTERATOM, Bensberg, Ger.). Atomkernenergie; 21: No. 2, 123-126(1973). (In German).

Shock-losses in channel flow, which are induced by discontinuities in cross-sectional area, are analyzed, taking into account a given velocity profile. The problem which is originally three-dimensional may be reduced to a two-dimensional one by means of a geometry transform which is practicable for complex geometries, too. It can be easily deduced that, apart from lateral expansion, the geometrical arrangement of a disturbance is of importance to the numerical value of pressure drop at its entrance. The total shock-loss is composed of a loss due to separation and a loss of momentum in the downstream flow. (GE)

18167 TRANSIENT HEAT TRANSFER FOR BOILING WATER AT A VERTICAL PLATE OF A REACTOR PRESSURE VESSEL. Burck, E.; Hufschmidt, W.; de Clercq, E. (Commission of the European Communities, Ispra, Italy). Atomkernenergie; 21: No. 2, 127-135(1973). (In German).

The problem of the transient temperature distribution and the resulting thermal stresses in the thick wall of a reactor pressure vessel is of great importance when the vessel, at its usual tem perature of about 300°C, is flooded with water at about 60°C from

the emergency cooling system; the resulting thermal stresses in the wall should not exceed the limits required to guarantee the integrity of the pressure vessel. On a section of a plated pressure vessel of 2 m height and 30 cm width quenching experiments were made with initial temperatures in the range of 150°C to 300°C and flooding water temperatures in the range of 30°C to 100°C. At the beginning of the cooling process, heat transfer occurs by film boiling. After about 2 seconds, the much higher heat transfer conditions of nuclear boiling are reached and lead then to natural or forced convection. In contrast to the known investigations of stationary pool boiling for small geometries the maximal heat flux densities are higher by a factor of two. For the investigation of the critical temperature differences and the maximum thermal stresses, cooling tests were made for a period of 30 min. These maximal values occur after about 4 to 5 min. Most of the experiments were made with cold water submerging the block from below. For complementary tests with cooling by a water film from above, no essential differences in the transient temperature distributions have been found. (GE)

Materials Testing

Refer also to abstracts 18661, 18663, 18737, 18798, 18928–18931, 18933, 18942, 20613, 20647, and 20657.

18168 (CONF-731003-2) COMPARISONS OF THEORETICAL AND EXPERIMENTAL STRESSES FOR SPHERICAL SHELLS HAVING SINGLE NONRADIAL NOZZLES. Gwaltney, R. C.; Greenstreet, W. L. (Oak Ridge National Lab., Tenn.). [nd]. 33p. Dep. NTIS $3.75.

From 2nd international congress for pressure vessel and piping technology; San Antonio, Texas, USA (1 Oct 1973).

An essential aspect of the design of pressure vessels and shell structures is the availability of analytical methods capable of providing realistic predictions of stresses and displacements for a proposed structure. Analyses of nonradial nozzles are considered and comparisons are made between stress distributions for a radial and a nonradial nozzle geometry. The calculated results are compared with experimental results obtained from extensively strain-gaged machined steel models which were tested to provide data for direct use in analytical method development and assessment. The nonradial nozzle was attached at an angle of 22½°, and both nozzles protruded into the vessels. Loading results compared are those for axial forces and pure bending moments applied to the nozzles and internal pressure loadings. Agreement between calculated and measured results was good, except in a few instances, and the maximum stress in each case was predicted with reasonable accuracy. Stress distributions for the nonradial and the radial nozzle attachments are quite similar. However, the higher stresses, both theoretical and experimental, occurred in the nonradial nozzle for all loading cases. (auth)

18169 PRODUCTION ULTRASONIC NDT-SYSTEM (1 APR 1969) (ENGINEERING MATERIALS). (California Univ., Livermore. Lawrence Livermore Lab.). (CAPE-2358).

145 drawings.

18170 INFLUENCE OF SOME X-RAY PENETRAMETERS ON CRACK DETECTION CAPABILITY. Ruescher, E. H. (Rockwell International, Inc., Los Angeles). Mater. Eval.; 31: No. 8, 152-154(Aug 1973).

To enable a crack to be detected by a person reading a radiograph, the defect must be portrayed with adequate photographic density difference, image sharpness, and lack of distortion. These image criteria are affected by the parameters of the radiographic process. Results of a study to investigate the effect of variations in radiographic parameters on the ability of experienced x-ray readers to recognize the x-ray image of actual cracks are reported. (auth)

18171 NOTE ON ACOUSTIC EMISSION MEASUREMENTS FROM LOW AND MEDIUM STRENGTH PRESSURE VESSEL STEELS. Kirby, N.; Bentley, P. G. Aust. Weld. J.; 17: No. 3, 23-28(1973).

A description is given of the following aspects of the UKAEA acoustic emission program: (1) development of high-sensitivity instrumentation for detecting and processing emission signals; (2) development of instrumentation and analysis for defect location; and (3) characterisation of emissions and patterns of emission for low- and medium-strength pressure vessel steels. (AT)

18172 NEUTRON RADIOGRAPHY IN INDUSTRY: TESTS PERFORMED AT CISE. Mangialajo, M. (CISE, Milan). Energ. Nucl. (Milan); 20: No. 6, 343-349(Jun 1973). (In Italian).

After a short introduction outlining bases and techniques of neutron radiography, the main development lines of industrial applications of this new nondestructive testing method are illustrated. The testing of electronic and electromechanical instrumentation; analyses and testing connected with the set-up of production, processes relevant to special materials; production testing for the aeronautical and aerospace industry; and quantitative analysis of hydrogen content in metals, with special regard to nuclear and aeronautical applications, are discussed. Some examples of applications are described, pertaining to the above items and performed at CISE in support of the research and development activities being carried out. (auth)

18173 POST-IRRADIATION EXAMINATION TECHNIQUES. Proceedings of the European Conference, Reading, England, March 11–23, 1972. London; Institution of Civil Engineers (1972). 250p. (CONF-720319-).

Forty-two papers were presented at the conference. A separate abstract was prepared for each. Session headings were: general; automation; radiography and nondestructive techniques; fission product release measurement; metallography; chemical evaluation; and techniques for mechanical properties. Discussions are included. (UK)

For abstracts of individual papers see: 17839, 17840, 17913–17915, 18174–18202, 18403, 18928–18933, and 20405.

18174 POST-IRRADIATION EXAMINATION TECHNIQUES USED AT STUDSVIK. Forsyth, R. S. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 1-5 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A brief description is given of those post-irradiation techniques used at Studsvik which reflect modern trends in development, or which, when used as complementary methods, give more complete information. The application of Ge(Li) solid state detectors to axial gamma scanning of fuel rods and for the determination of the radial distribution of fission products is described. Neutron radiography and accurate dimension measurements are also applied to specimens prior to destructive analysis. The use of beta autoradiography in conjunction with optical microscopy and electron microprobe examination is discussed. (auth)

18175 POST-IRRADIATION TECHNIQUES FOR EXAMINATION OF HIGH-TEMPERATURE REACTOR FUEL. Groos, E. (Kernforschungsanlage, Juelich, Ger.). pp 33-34 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Post-irradiation examination techniques used in the Hot-Cell Laboratories at KFA Juelich for the investigation of irradiated coated-particle fuel, fueled compacts, and in particular, spherical fuel elements for the German Pebble-Bed Reactors (AVR and THTR), are described. They include the measurement of dimensions, mechanical strength and fission product release, sectioning and sampling for various further examinations, selection and handling of individual coated particles, and tests on single particles. (auth)

18176 SAMPLING FROM FUELLED SPHERES AND IRRADIATED GRAPHITE PIECES. Herren, M. (Kernforschungsanlage, Juelich, Ger.). pp 35-38 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

In the course of post-irradiation examination of fueled spheres for gas-cooled high-temperature reactors, it is necessary to take samples for gamma spectrometry, metallography, examination of graphite properties, etc. Among other things, particular demands are taking of samples at exactly defined positions and without cross-contamination. Techniques and machines used for the trepanning of pins and machining of powder samples from spherical fuel elements and graphite pieces surrounding the spheres during irradiation in the test assemblies are described. (auth)

18177 FISSION-GAS ANNEALING TEST IN POST-IRRADIATION EXAMINATION. Stradal, K. A. (Kernforschungsanlage, Juelich, Ger.). pp 39-41 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

One of the most important problems in connection with ceramic HTR fuel elements is the knowledge of their fission product retention properties. The fission gas release can be measured during in-pile irradiation experiments. For out-of-pile determination of fission gas release, the annealing test apparatus described was designed and constructed. (auth)

18178 APPLICATION OF THE KFA ANNEALING TEST TECHNIQUE TO EXAMINATION OF IRRADIATED HTGR FUEL. Ra-

goss, H. (Kernforschungsanlage, Juelich, Ger.). pp 45–47 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

The main field of application of the KFA annealing test technique to post-irradiation examination of HTGR fuel is the determination of the in-pile fission gas release by measurement of either initial fission gas burst or steady-state release. The possibilities of estimating transport and evaporation coefficients and plate-out factors for solid fission products are described briefly. (auth)

18179 SPECIAL APPLICATIONS OF GAMMA SPECTROMETRY IN TESTING SPHERICAL FUEL ELEMENTS. Duwe, R. (Kernforschungsanlage, Juelich, Ger.). pp 49–51 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

In the hot-cell laboratories at KFA, the burnup of spherical fuel elements from the AVR and irradiations for HTR fuel development is determined by gamma-spectrometric measurement of ^{137}Cs produced by fission. Fuel elements with geometrically different fuel distribution can be distinguished by gamma scanning. For this purpose, the fueled sphere is moved across the slit of a collimator in order to measure the activity distribution along a diameter. A similar device is in use for nondestructive determination of fission products migrated into the fuel-free zone. The equipment and method of use are described. (auth)

18180 FACILITY FOR MEASURING YOUNG'S MODULUS AND RUPTURE STRESS OF THE COATING OF COATED PARTICLES. Mueller, H. W. (Kernforschungsanlage, Juelich, Ger.). pp 53–55 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A facility is described which is used to test the coating of coated fuel particles before and after irradiation. During pressing of a particle between two sapphire plates, the force is measured by a piezo crystal and plotted versus the distance between the plates, thus obtaining a stress–strain diagram. The particles can be observed during cracking by a microscope. The beginning and the shape of cracks can thus be observed. The facility is shielded by 5 cm of lead and is connected with a hot cell by a pneumatic tube. Some results are presented as examples. (auth)

18181 POST-IRRADIATION EXAMINATION OF DRAGON PROJECT HIGH-TEMPERATURE FUEL. Barr, P. B. (Organization for Economic Co-Operation and Development, Dorchester, Eng.); Mayr, K.; Carter, D. H.; Evans, J. H. pp 57–62 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

The Dragon Reactor experiment is used to investigate the irradiation performance of a wide variety of high-temperature gas-cooled reactor fuels and components. All initial post-irradiation dissection work and much of the post-irradiation examination of all the experimental fuel elements is carried out in a small suite of hot cells at Winfrith. The discharge rate of fuel elements and their subsequent post-irradiation examination has necessitated the installation of a variety of special purpose in-cell jigs and fittings. A description of the techniques and special-purpose apparatus is given. A description is also given of the equipment installed in two concrete shielded cells at AERE Harwell for the metallographic preparation of samples of irradiated Dragon fuel materials. Details are also given of a lead-shielded macro-camera and optical microscope used for photomicrography of the fuel samples. (auth)

18182 TECHNIQUES USED IN THE DRAGON PROJECT TO MEASURE THE FISSION-PRODUCT RELEASE PERFORMANCE OF HIGH-TEMPERATURE REACTOR FUEL. Nabielek, H.; Hick, H.; Good, P. D.; York, J.; Neubauer, J.; Ohman, H. (Organization for Economic Co-Operation and Development, Dorchester, Eng.). pp 63–74 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

High-temperature gas-cooled reactor fuel elements have no hermetic metal cans surrounding the fissile material to prevent fission products escaping into the primary coolant. Instead, the fissile material is divided into microspheres which are coated with pyrocarbon and silicon carbide to prevent the release of fission products. In any development program on such fuel, its fission-product retention performance is of paramount importance, and for this reason a variety of techniques have been developed and are used during post-irradiation examination of fuel elements irradiated in the Dragon Reactor. A description is given of the techniques of assaying for the release of gamma-ray-emitting solid fission products, using high-resolution gamma spectrometry; beta-emitting fission products, by autoradiography and beta counting; and fission-gas release by annealing. (auth)

18183 AUTOMATIC DEVICES FOR MEASURING DIMENSIONS, ELECTRICAL RESISTIVITY, AND YOUNG'S MODULUS OF IRRADIATED GRAPHITE SPECIMENS. Blackstone, R.; Heeringa, K.; Luyckx, H. J. B. L.; Oosterman, B. L. H. (Reactor Centrum Nederland, Petten). pp 79–85 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A description is given of three automatic devices which are used at Reactor Centrum Nederland, Petten, for the post-irradiation examination of specimens of reactor graphite. The devices were developed mainly to increase the output, not for remote handling. Full use is made of digital data output and data evaluation, including plotting, by a computer. (auth)

18184 AUTOMATED SYSTEM FOR GAMMA SCANNING DISCHARGED AGR FUEL PINS. Polley, M. V. (Central Electricity Generating Board, Berkeley, Eng.). pp 87–91 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Extensive post-irradiation examination work is involved in the advanced gas-cooled reactor program. One of the examination procedures will be gamma scanning, in which the relative activities of certain fission products will be measured as a function of axial position along individual fuel pins. The purpose is to check the A.G.R. data operating system (ADOS) by comparing measured activities with those predicted by ADOS. Another purpose is to detect fuel and cladding failures. A PDP11 computer will control fuel pin movement, data collection and data output, and gamma spectra will be accumulated from two rigs using Ge(Li) detectors. The computer will be programmed to allow several different automatic procedures as well as semi-automatic control. The design of the system is discussed in detail, and an outline of the aims and purposes of the work is given. (auth)

18185 AUTOMATED MEASUREMENT OF REACTOR-INDUCED STRAIN IN IRRADIATED CYLINDRICAL FUEL PINS AT HARWELL. Demant, J. T. (Atomic Energy Research Establishment, Harwell, Eng.). pp 97–100 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

The causes of reactor-induced strain in cylindrical fuel elements are briefly outlined and an automated machine for scanning the surface of experimental fuel pins after irradiation is described. The machine uses linear displacement transducers with electronically controlled pin traverse and rotation. The digital output data, consisting of position coordinates with associated diameter and bow measurements, is computer processed to plot and tabulate results in readily intelligible form. (auth)

18186 AUTOMATIC HANDLING AND MEASUREMENT OF FUEL ELEMENTS AT DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT. Robertson, A.; Jennison, W. (Dounreay Experimental Reactor Establishment, Scotland). pp 101–105 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Measurement techniques for comparison of pre- and post-irradiation parameters of fuel elements are under continuing development at DERE. Few earlier machines were even partly automatic as the size and number of elements did not warrant this. However, with the increased throughput of the Prototype Fast Reactor, automatic identification, handling, diameter, length, weight, and profile measurement are now necessary. The machines and control systems currently designed for measurement of the parameters required on an automatic or semi-automatic basis, are described. (auth)

18187 PRODUCTION AND AUTOMATIC MEASUREMENT OF IRRADIATED FUEL-ELEMENT RADIOGRAPHS. Uglow, A. F.; Molloy, T. (Central Electricity Generating Board, Berkeley, Eng.). pp 111–116 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

The use of radiographs for the accurate determination of dimensional changes in irradiated Magnox/uranium fuel elements is discussed. The principles of the process are examined, together with

the effect of film fogging by γ rays. The method based on the use of a standard film and conventional radiographic and processing technique is described. The time that the film remains in the γ-ray environment is limited by the use of a high-powered x-ray source coupled with a fast film transfer mechanism, to control the level of film fogging. The properties of an edge as revealed on a radiograph and the technique developed to automatically measure and record the dimensions of the fuel rod image are considered. The current technique uses a quantitative television microscope producing data recorded on punch tape in a form for computer processing. The need for increased measuring speeds has resulted in the development of a specially built instrument whereby an edge is detected using an array of photodiodes. Application of the above technique for the measurement of dimensional changes in AGR fuel pins is indicated. (auth)

18188 RADIOGRAPHIC EXAMINATIONS AFTER IRRADIATION. Mansard, B.; Picavet, C.; Roussel, E. (CEN de Saclay, Gif-sur-Yvette, France). pp 117-124 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Work at Laboratoire d'Etudes des Combustibles Irradies on the post-irradiation examination of fuel elements and experimental reactor rigs is described. Facilities are available for dealing with most of the problems generally arising, and arrangements may be made to cope with particular problems. Examples are given of destructive and nondestructive testing. Particular attention is devoted to ordinary radiography, which despite the advent of neutron radiography, is still very useful and provides an easy and relatively cheap basic process in nondestructive testing. X-ray photography also complements neutron radiography. Details are given of the equipment available. (UK)

18189 USE OF EDDY-CURRENT METHODS TO EXAMINE IRRADIATED FUEL PINS. Prestwood, J.; Sumerling, R. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 125-128 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Eddy-current testing is now being used as a method of examining Zircaloy-clad UO_2 fuel pins irradiated in water reactors. The detection equipment is a commercially available instrument which employs phase discrimination of signals and is operated in the range 20 to 100 kHz. This high frequency ac is fed to a matched pair of differentially wound sensing coils which encircle the tubing to be tested. (auth)

18190 MEASUREMENT OF SMALL DENSITY CHANGES IN HIGHLY RADIOACTIVE MATERIALS. Lobb, R. C.; Ratcliffe, R. T.; Harris, J. E. (Central Electricity Generating Board, Berkeley, Eng.). pp 129-131 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A differential method of measuring small density changes based on Archimedes principle is adapted for determining volume changes in highly active specimens. The apparatus is simple and robust and capable of measuring fractional density changes of 2×10^{-4}. Examples are given of its use for studies with irradiated Zr and U specimens. (auth)

18191 DETERMINATION OF FREE VOLUMES AND GAS CONTENT OF COATED FUEL PARTICLES FOR GAS-COOLED REACTORS. Bildstein, H.; Strigl, H. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). pp 149-150 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

In order to assess the stability of coated fuel particles against internal gas pressures, experimental techniques are developed for the determination of free volumes, internally available for pressure buildup, and of the content of gases (fission products and reaction gases) in single coated fuel particles. A microvolumeter is described and results given for free volumes in comparison with values calculated from measured properties such as dimensions, porosity, and density. In reference particles, typical values of 5 to 10×10^{-4} cc are reproducible to $\pm 10\%$ and indicate that virtually all porosity provided in the buffer layer is accessible for gases at internal pressures equal to or above 10^7 N/m^2. A high-vacuum, high-temperature crushing system allows the simultaneous determination of several gases in single particles by mass spectrometry. Results are obtained for the internal release of fission gases as well as for the formation of carbon monoxide in particles with oxide kernels. The influence of irradiation conditions such as time, temperature, and burnup upon the release values and upon the internal pressure is discussed. (auth)

18192 DEVICE FOR MEASUREMENT OF RUPTURE STRENGTH OF IRRADIATED HTR PARTICLES. Janvier, J. C.; Blanchard, R. (CEN, Grenoble, France). pp 151-157 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

An automatic device to measure the rupture strength of a single particle and to record the strength–strain curves was studied in a hot cell. The gases released at the rupture can be swept by helium and collected in a charcoal trap. The operation can be interrupted at any time and therefore it is possible to avoid destruction of the kernel. The crushing strength of the HTR-irradiated particles is a measurement of their mechanical strength, which bears a relationship to their conditions of irradiation. On the other hand, coatings and kernels need to be separated in order either to proceed with their examination under the scanning electron microscope or to measure their burn-up and fission gas release, and in order to do this, kernels must not be broken. The apparatus described allows breaking of the coatings leaving the kernel unbroken and collection of the fission gases located in the free volume of the particle, also plotting of the stress virus strain curve. Consideration of this curve gives the crushing strength of the particle, the total amount of work done to break it, and a good enough approximation of its elastic behavior. (auth)

18193 DETERMINATION OF FISSION GAS RELEASE FROM KERNELS OF HTR PARTICLES. Blanchard, R.; Janvier, J. C. (CEN, Grenoble, France). pp 159-163 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A method is described for determining both the released and the retained fractions of ^{85}Kr in coated irradiated kernels. The techniques used involve: (1) mechanical rupture of the coating under vacuum and recovery of the gases released in to the free volume of the particle; this operation is performed at 600°C in order to avoid any gas retention due to physical adsorption; and (2) evaporation of the kernel under vacuum at 2000 to 2200°C; during this operation the gases are continuously extracted. The apparatus used allows the gases to be swept by helium and recovered into cooled charcoal traps. (auth)

18194 DETERMINATION OF THE INTERNAL FREE VOLUME AND PRESSURE OF IRRADIATED UO_2 ZIRCALOY-CLAD FUEL PINS. Bagger, C.; Bryndum, K. (Danish Atomic Energy Commission, Risoe). pp 165-167 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A technique is described for the measurement of the free volume and gas pressure inside BWR-type fuel pins. The method employed is to pierce the pin and extract the fission gas into a volume measuring device. The evacuated pin is then filled to a known pressure with helium, and the volume of helium is measured. The internal free volume, together with a known unavoidable dead volume, can then be determined, and the internal pressure of the extracted fission gases can be calculated from the data obtained. The error of the system is less than 1% for free volumes of approximately 20 cc, and the accuracy improves with larger free volumes. (auth)

18195 FISSION-GAS RELEASE MEASUREMENTS ON IRRADIATED FUEL PINS. O'Keefe, J. M.; Kirkbride, R. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 169-172 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Techniques are described that have been developed at Windscale for the measurement and analysis of gas release in a variety of fuel pin designs. These techniques range from mechanical devices to advanced methods employing puncture by laser beams. (auth)

18196 DETERMINATION OF GASES IN COATED-PARTICLE AND CERAMIC FUELS. Clough, D. J.; Horsley, G. W.; McMillan, J. W.; Sheldon, B. E.; Taylor, B. L.; Weldrick, G. J.; Williams, J. (Atomic Energy Research Establishment, Harwell, Eng.). pp.173-178 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A number of techniques are described which have been developed

to study the influence of gaseous fission products on the irradiation behavior of coated particle and ceramic fuels. Examples are given of relevant results obtained by these methods. (auth)

18197 TECHNIQUE FOR OBSERVATION OF MICRO-SEGREGATION OF CESIUM IN IRRADIATED FUEL PINS. Clifton, M.; Jepson, M. D. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 189-190 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Developed from chemical spot tests, this simple technique enables cesium-rich areas less than 1 μm in diameter to be detected on metallographic specimens using conventional optics. The spot size is equivalent to about 10^{-12} g Cs. (auth)

18198 TECHNIQUE FOR PREPARING ELECTRON-MICROSCOPY SPECIMENS FROM REACTOR FUEL ELEMENTS. Baker, C.; Reynolds, G.; Bannister, G. H. (Central Electricity Generating Board, Berkeley, Eng.). pp 191-193 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Electron metallography can yield quantitative information on the volume of optically visible voidage and of the submicron gas bubbles produced in reactor fuel elements by neutron irradiation. The modification of conventional electron microscope specimen preparation to deal with highly active material is described. Examples are given of the structures observed in highly irradiated Magnox and AGR fuel elements. (auth)

18199 DISTRIBUTION OF FISSION PRODUCTS IN COATED FUEL PARTICLES STUDIED BY ION SPUTTERING. Loidl, A.; Pichlmayer, F.; Riehs, P. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). pp 211-214 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Irradiated uranium carbide fuel particles were investigated using the sputtering method. The PyC/SiC/PyC coating showed within the SiC layer a steep gradient of ^{137}Cs concentration towards the kernel. This increase was followed by a maximum, which coincided presumably with the transition between SiC and PyC. A similar distribution, with a much better pronounced maximum, was found for ^{106}Ru. It is assumed that the maxima were caused probably by different partitions of Cs and Ru in SiC in comparison to the PyC layer. The increase of ^{144}Ce started within the inner PyC coating. Analyzing one particle in the outer PyC layer for ^{90}Sr the same shape was found as for ^{144}Ce. (auth)

18200 APPLICATIONS OF HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY IN POST-IRRADIATION EXAMINATION OF NUCLEAR FUEL MATERIALS. Banham, M. F.; Fudge, A. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 227-233 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

High-resolution gamma ray spectrometry, using Ge(Li) detectors, enabled data to be obtained with very much greater certainty on the qualitative and quantitative distribution of fission and activation products in irradiated nuclear fuel materials. Intact fuel elements were scanned using these detectors and the data used to determine burn-up distribution and fission-product migration, and to measure dimensional changes. Radial and axial cross sections were examined in greater detail using a micro-scanner for cross pin flux gradient measurements. The equipment and cells used for this work are described and typical results given to illustrate the potential of this technique. (auth)

18201 POST-IRRADIATION MECHANICAL TESTS AT DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT, SCOTLAND. Ellen, F. P.; Durie, P. I. (Dounreay Experimental Reactor Establishment). pp 239-242 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A review of the apparatus available for tensile testing, tensile stress rupture testing, and tube bursting tests on irradiated materials is followed by a detailed description of the apparatus developed and of the techniques evolved. Facilities are described for tensile tests at loads up to 20 kN and temperatures to 850°C, for rupture testing at loads up to 10 kN and temperatures to 750°C, and for tube bursting at pressures up to 100 MN/m^2 and temperatures up to 1000°C. Temperature transient bursting facilities are described which allow heating rates in excess of 50°C/s to a maximum temperature of 1500°C and a pressure of 35 MN/m^2. (auth)

18202 BURST TESTING OF CLADDING FROM IRRADIATED FUEL PINS. Hindmarch, P.; Russell, A. I. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 243-246 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Two techniques are described for measuring stress-rupture properties and ductility of irradiated cladding from SGHWR and AGR fuel pins by internal pressure burst testing. For the former, test temperatures and dimensions necessitate high applied hoop stresses and hence hydraulic pressurization; for the latter, testing involves lower hoop stresses and higher temperatures, so that gas pressurization is used. For both cases the burst test is of the closed-end-type, that is, the cladding is stressed biaxially with the longitudinal stress equal to half the hoop stress. (auth)

Nuclear Explosions

18203 (AD-757877) SEISMIC PATTERN RECOGNITION. Bouvier, R. D. (Air Force Inst. of Tech., Wright Patterson AFB, Ohio. School of Engineering). Dec 1972. 129p. (GE/EE-73-2). NTIS.

Thesis.

Various pattern recognition techniques are applied to the problem of discriminating underground nuclear explosion seismic signals from those of natural earthquakes. The data set consists of 186 short period seismograms recorded by the Large Aperture Seismic Array in Montana. Enough seismic and pattern recognition theory is developed to allow easy interpretation of the results. The techniques tested run the gamut from simple, linear classifiers to a complex, adaptive, nonlinear classifier. The best results were 99.4% correct identification of earthquakes and 94.2% correct identification of explosions. (auth)

18204 (AD-758213) QUICK-LOOK BLAST CHARTS. Technical Report, May 1971-June 1972. Brock, T. K. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Mar 1973. 53p. (AFWL-TR-72-163). NTIS.

Presented are a collection of charts and instructions for their use that may be used to obtain estimates of the free-field blast effects (gust and over-pressure) resulting from the detonation of a nuclear weapon. The report is intended to be an easy-to-use reference for preliminary calculations where blast parameters are required for input to systems analysis problems and based on the computer program SABER used at AFWL for environment calculations in support of systems analyses. Included is a simplified computer program that will give the same results as the charts. (auth)

18205 (AD-758430) EARLY TIME AIR FIREBALL MODEL FOR A NEAR-SURFACE BURST. Pomraning, G. C. (Science Applications, Inc., La Jolla, Calif. (USA)). Mar 1973. Contract DNA001-73-C-0012. 31p. (SAI-72-588-LJ; DNA-3029-T). NTIS.

An integral part of the 1D-2D synthesis technique used to estimate the energy coupled into the ground from a near-surface burst is a simplified air fireball model. One of the main limitations of the model currently in use is the assumption that the device output is a square wave in time, i.e., the device radiates at a constant rate for a finite period of time. Analytic modeling work in the coupling problem has indicated that the time dependence of the device output is an important parameter in determining the radiative energy coupled into the ground. The purpose of the report is to describe in some detail this reformulation of the air fireball model. As in the current model, this reformulation envisions the air "burning out" at a fixed temperature, i.e., for air temperatures less than the burnout temperature, the air opacity is assumed very large, and for air temperatures greater than the burnout temperature the air opacity is assumed very small. (auth)

18206 (CONF-730907-6) EVALUATION OF NUCLEAR GAS STIMULATION IN TERMS OF POTENTIAL RADIATION EXPOSURE TO THE PUBLIC. Rohwer, P. S.; Barton, C. J.; Moore, R. E.; Kaye, S. V. (Oak Ridge National Lab., Tenn.). 1973. 18p. Dep. NTIS $3.00.

From 3rd international congress of the International Radiation Protection Association meeting; Washington, District of Columbia, USA (9 Sep 1973).

Experience gained from Projects Gasbuggy and Rulison and their follow-up studies indicates that natural gas produced from a nuclearly stimulated well field will contain small amounts of man-made radioactivity as it leaves the gas processing plant and

enters commercial distribution channels. Individual and population doses have been estimated for hypothetical uses of such gas. For example, it is estimated that residential use of nuclearly stimulated gas in unvented cook stoves would result in an average whole-body dose to the house occupants of approximately 0.2 mrem/y. Radon concentrations measured in natural gas at various locations in the United States average approximately 20 pCi/l. Assuming this concentration of radon in the unvented cooking case mentioned, the lung dose is estimated to be 1.5 mrem/y. All of the dose estimates discussed are used to give perspective to the additional radiation exposure of the public which could occur due to use of gas from nuclearly stimulated wells. Both somatic risk and genetic risk are considered in the assessment of relative hazard. Comparisons are made with other risks encountered in the normal activities of life in the United States. The studies summarized show that the radiological impact of either domestic or industrial use of the gas can be small. (auth)

18207 (FOA-4-4538-A-1) EARTHQUAKE IN THE CRIMEA REGION, JULY 22, 1972. Event Report No. 6. (Hagfors Observatory, Stockholm (Sweden)). May 1973. 32p. Dep. NTIS (U. S. Sales Only) $3.75.

The recorded short- and long-period signals and their spectra obtained at the Hagfors Observatory in Sweden from an earthquake in the Crimea Region, USSR, July 22, 1972 are reported. (auth)

18208 (FOA-4-4539-A-1) PRESUMED EXPLOSION IN S. W. USSR, JULY 9, 1972. Event Report No. 7. (Hagfors Observatory, Stockholm (Sweden)). May 1973. 10p. Dep. NTIS (U. S. Sales Only) $3.00.

The recorded short- and long-period signals and their spectra obtained at the Hagfors Observatory in Sweden from a presumed nuclear explosion in South Western USSR July 9, 1972 are reported. (auth)

18209 (FOA-4-4545-A-1) SEISMIC SOURCE AND TRANSMISSION FUNCTIONS FROM UNDERGROUND NUCLEAR EXPLOSIONS WITH KNOWN YIELDS AT NEVADA TEST SITE. Dahlman, O. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jun 1973. 38p. Dep. NTIS (U. S. Sales Only) $4.00.

A model is presented for the simultaneous determination of the relative variation in transmission properties to different stations and of the relative differences between the seismic sources for closely spaced underground nuclear explosions recorded by a fixed seismological station network. The model is applied to short-period data reported from 24 globally distributed stations from 12 underground nuclear explosions with known yields at Nevada Test Site. The obtained transmission functions vary within a factor of 10 between the different stations and show a weak decrease with epicenter-distance and little correlation with Gutenberg amplitude-distance curve. The relative source functions for 10 explosions in tuff and rhyolite, with yields in the range 16 to 1200 kt are with good correlation proportional to explosion yield to 0.9. Two theoretical models, one by Haskell and one by Mueller-Murphy, are compared with each other and they agree well for frequencies around 1 Hz and for yields in the range 3 to 300 kt. The Haskell model for tuff is modified to be more compatible with the models for salt, granite, and alluvium. The Haskell model predicts stronger amplitude variation with frequency and yield than the Mueller-Murphy model. The observed relative source functions are compared with the relative amplitudes obtained from the two source models. The agreement is fairly good when some modifications of the parameters in the Haskell models are made. (auth)

18210 (NOAA-TM-ERL-ESL-22) SEISMIC BACKGROUND NOISE INVESTIGATIONS AROUND THE WAGON WHEEL SITE. Navarro, R. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Mar 1973. 26p. (PNE-WW-29). Dep. NTIS $3.50.

During the week of August 13, 1972, the Nevada Special Projects Party of the Earth Sciences Laboratories (ESL) conducted a seismic noise investigation for El Paso Natural Gas Company (EPNG). Ambient seismic noise studies were made at 19 locations in Wyoming in the vicinity of the Project Wagon Wheel site. On August 17, at approximately 1800 GMT a 55,000 lb. high explosive (HE) quarry blast detonated at a location 50 mi east of Wagon Wheel was recorded at two of the locations investigated. This memo describes the operation, documents the results, and gives analyses of the records. (auth)

18211 (NVO-1163-TM-38) DISTANCE ATTENUATION OF RESPONSE SPECTRA FROM UNDERGROUND NUCLEAR DETONATIONS. Lynch, R. D. (Environmental Research Corp., Las Vegas, Nev.). Jul 1973. Contract AT(29-2)-1163. 62p. Dep. NTIS $5.25.

Response spectral data covering the period range 0.05 to 2.469 seconds were analyzed using the statistical model of analysis of covariance to determine distance scaling exponents. Data grouped according to two event areas, Pahute Mesa and Yucca Flat, were analyzed separately and as a combined sample. The analysis showed that the distance scaling exponents are period-dependent and range in value from approximately –1.0 for periods greater than 1.0 second to approximately –1.5 at 0.10 seconds. The average deviation from the expected value of data for 13 stations was computed. It is shown that most stations consistently deviate from the expected value and that at certain stations and periods, the average deviations are as much as a factor of 5 above or a factor of 4 below the expected value. (auth)

18212 (UCRL-50929(Rev.1)) AIDS FOR ESTIMATING EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS. Butkovich, T. R.; Lewis, A. E. (California Univ., Livermore. Lawrence Livermore Lab.). 23 Feb 1973. Contract W-7405-eng-48. 104p. Dep. NTIS $5.45.

Useful relationships for estimating the effects on the surrounding media of underground nuclear explosions are summarized in graphical and mathematical form. Parameters considered include device yield, depth of burst, cavity volume and radius, chimney height, distance from shot point, fracture radius, mass of rock in the chimney, in situ and grain density, porosity, water content, compressional velocity, Poisson's ratio, overburden pressure, radius of vaporization, radial stress and displacement, particle velocity and acceleration, ground-surface acceleration and displacement, and temperature increase. (auth)

18213 (UCRL-51396) MAGNETIC INDUCTION: A SYSTEM FOR WIRELESS DOWNHOLE COMMUNICATION IN CASED HOLES. Rodgers, P. W. (California Univ., Livermore. Lawrence Livermore Lab.). 25 May 1973. Contract W-7405-eng-48. 17p. Dep. NTIS $4.00.

The sequential detonation of a series of nuclear explosives in the same drill hole requires some type of alternate cableless communication for command and control because of the possibility that the primary cable link may be destroyed by the initial detonation. Communication by both seismic and electromagnetic (EM) propagation is possible. An EM method, selected because of the likelihood of a large but unspecified seismic background noise following the initial detonation that might interfere with seismic communication, is described. The system consists of a large horizontal surface loop driven at a low frequency, and a vertical many-turn downhole receiving coil. The downhole coil senses the low-frequency induction field produced by the surface loop. The attenuation due to the conducting rocks and the attenuation through the steel well casing is accounted for theoretically and measured experimentally. A field experiment is described which verifies the theory and practicality of the method. (auth)

18214 SHOCK INPUT FOR EARTHQUAKE STUDIES USING GROUND MOTION FROM UNDERGROUND NUCLEAR EXPLOSIONS. Bernreuter, D. L.; Norris, D. M. Jr.; Tokarz, F. J. Shock Vib. Bull.; No. 42, 21-31(Jan 1972).

The failure of many structures, including the catastrophic collapse of multistory buildings during the 1971 San Fernando earthquake, shows that currently used design criteria for resistance to earthquakes are inadequate. The criteria used in California building codes are based on the use of static analyses, whereas design that includes dynamic analysis is necessary to guarantee basic survivability of buildings and other structures. Because little data on the dynamic behavior of structures during earthquakes exist, it is suggested that the ground motion produced by underground nuclear explosions be used to excite test structures, in order to improve knowledge in this area. A discussion of the merits of several criteria used to characterize earthquakes for structural studies is given. Comparisons, on the basis of peak accelerations, relative velocity spectra, and time histories, are made between the ground motion that occurred during a number of earthquakes and during underground nuclear explosions. It was concluded that the latter generates ground motions similar to those that occur during earthquakes and could be used to produce the excitation necessary for conducting tests on full-scale structures. (App. Mech. Rev.)

18215 SOURCE CHARACTERISTICS OF EARTHQUAKES, EXPLOSIONS, AND AFTEREVENTS. McEvilly, T. V.; Peppin, W. A. (Univ. of California, Berkeley). Geophys. J. Roy. Astron. Soc.; 31: No. 1-3, 67-82(Dec 1972).

From seismic discrimination meeting; Cambridge, MA (19 Jan 1972).

Broad-band seismic data available on the magnetic tape library at Berkeley have been used in a study comparing P_n and Rayleigh waves from earthquakes, explosions and explosion afterevents, both collapse and earthquake types. Eighty-one events equidistant from

Berkeley at 500 to 550 km provided the data for wave amplitude and spectra comparisons. Explosions exhibit characteristic low Rayleigh wave (12s period) generation, for given P_n amplitude, relative to earthquakes, as well as explosion afterevents. This discriminant, for events recorded at Berkeley is well developed down to local magnitude M_L 4.0 or less ($m_b \approx 3.6$) and shows no indication of convergence, although scatter increases, for smaller events. Rayleigh wave spectra for explosions and collapses are quite similar, the similarity continuing up to frequencies of 0.5 Hz for proximate events, but they differ significantly from spectra of shallow earthquakes in the same source region. This implies the explosions, including large ones with appreciable surface faulting, Love wave generation, and aftershock sequences, are sources with small time and space dimensions, relative to shallow earthquakes at the same site. Extensive fault displacements near large explosions are proposed as passive medium response to strong shaking, and Love wave generation with Rayleigh wave asymmetry is suggested to occur through processes acting in the relatively small high stress explosive source region. (auth)

18216 SOURCE TIME FUNCTIONS AND SPECTRA FOR UNDERGROUND NUCLEAR EXPLOSIONS. von Seggern, D.; Blandford, R. (Teledyne, Inc., Alexandria, VA). Geophys. J. Roy. Astron. Soc.; 31: No. 1-3, 83-97(Dec 1972).

From seismic discrimination meeting; Cambridge, MA (19 Jan 1972).

The model of Haskell (J. Geophys. Res., 72: 2583 (1967)) for explosion source time functions and spectra fails to satisfy data in the short-period band recorded teleseismically from the three Amchitka Island underground nuclear tests LONGSHOT, MILROW, and CANNIKIN, but more recent model due to Mueller and Murphy (Bull. Seis. Soc. Amer., 61: 1675 (1971)) satisfies the data quite well. The difference in the two models is basically in the fall-off at high frequencies. A simple revision of Haskell's model, however, produced waveforms and spectra nearly identical to those from Mueller and Murphy's model. This revision requires velocity waveforms to have a rise time of extremely short duration at the elastic boundary, a premise validated by actual near-field measurements. Waveforms are derived from the revised Haskell model and the Mueller and Murphy model and illustrated for pressure at the elastic boundary, reduced displacement potential at the elastic boundary, and far-field displacement. Corresponding spectra are derived and illustrated. (auth)

Protective Structures and Equipment

18217 (RFP-Trans-132) CEA POLICY IN THE DESIGN, MANAGEMENT, AND SAFETY OF HOT FACILITIES. Mas, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. Translated from IAEA Paper SM-125/49. 14p. Dep. NTIS $3.00.

For each of the various categories of hot installations in France, an outline is given of the evolution of the ideas adopted for the construction of these C. E. A. installations. The French conception of the security of personnel, particularly in the case of hot installations, is then examined. The principles, methods, and procedures which have been satisfactory and which can be adopted for future installations are reviewed. (JSR)

18218 (RFP-Trans-133) THREE YEARS OF EXPERIENCE IN THE HANDLING OF IRRADIATED PLUTONIUM, AMERICIUM, AND CURIUM. Samsel, G.; Vaane, J.; de Ras, E. (European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.). [nd]. Translation of IAEA Paper SM-125/52. 11p. Dep. NTIS $3.00.

The hot laboratory of the Institut européen des transuraniens has been in operation since the end of 1966. In its cells extremely varied examination work has been carried out in connection with fuel elements for thermal reactors, experimental elements for fast reactors, irradiation capsules, and large quantities of irradiated transplutonium elements, such as americium and curium. During these three years of operation, culminating in the fabrication of an isotope battery with the handling of 1 g of ^{242}Cm, no serious incident has occurred in the laboratory. However, although during this period certain basic design features selected when the laboratory was constructed have proven entirely satisfactory, others have been modified so as to adapt them fully to the requirements of operation and safety. In this connection the characteristic facilities of the laboratory, namely the $\alpha\beta\gamma$ cells, the bootings of the direct manipulators, the ventilation systems of the cells, the fire protection systems, and the contamination detection systems, are reviewed and submitted to a critical examination. The conclusions which can be drawn at the end of this first phase of operation are on the whole positive, which must be attributed both to technical measures, of which the most important are the use of bootings in the cells with high alpha contamination and with an extremely corrosive atmosphere, and the double-cover systems for operations in medium-activity cells, and also to co-ordination between those responsible for the construction, operation and safety of the laboratory. (auth)

18219 (UCRL-50007-72-3) HAZARDS CONTROL PROGRESS REPORT No. 44, SEPTEMBER-DECEMBER 1972. Odell, B. N. (ed.). (California Univ., Livermore. Lawrence Livermore Lab.). 29 Mar 1973. Contract W-7405-eng-48. 24p. Dep. NTIS $4.00.

Separate abstracts were prepared for the six sections of the report. (TFD)

For abstracts of individual sections see: 18220, 18221, 18334, 18351, 18390, and 18916.

18220 (UCRL-50007-72-3, pp 6-8) EFFECT OF CONCENTRATION ON RESPIRATOR CARTRIDGE EFFICIENCY. Nelson, G. O.; Harder, C. A. 29 Mar 1973.

In hazards control progress report No. 44.

The service life of organic vapor respirator cartridges was determined for various concentrations of acetone and benzene. The test results indicate that the time to reach a given breakthrough increases as the concentration diminishes, but that the time-concentration relationship is not inversely proportional to the concentration. (TFD)

18221 (UCRL-50007-72-3, pp 8-11) HEPA FILTER FIRE PROTECTION. Bolton, P. N.; Bigler, B. E.; Ford, H. E. Jr. 29 Mar 1973.

In hazards control progress report No. 44.

Results of continued experimental work aimed at protection of HEPA filters from the effects of heat and smoke generated in unwanted fires are reported. (TFD)

18222 SUPPLY OF GASES IN THE NEW PLUTONIUM LABORATORY OF THE GFK, KARLSRUHE. Dippel, T.; Kurzenhaeuser, O. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). G-I-T (Glas-Instrum.-Tech.) Fachz. Lab.; 17: No. 4, 345-348 (1973). (In German).

Various gases, both for processing and for protection, must be made available for production and testing procedures in the plutonium laboratory. The installations required for this purpose and the necessary protective measures are described. (GE)

Safety Engineering

Refer also to abstract 18214.

Vacuum Engineering

Refer also to abstract 18938.

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstract 17842.

18223 (CONF-700705-(Vol.2), pp 533) LOCALIZATION OF URANIUM AND THORIUM IN ROCKS AND MINERALS WITH INDUCED FISSION TRACKS AND THE RADIOLUXOGRAPH. Dooley, J. R. Jr.; Block, W. C.; Moore, L. Jr. (Geological Survey, Denver). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The radioluxograph method can be used with neutron-induced fission tracks to determine the distribution of natural radioactivity from uranium and thorium and to indicate the surface distribution of more abundant and longer half-life radionuclides in the major rock-forming minerals. (DHM)

18224 REVIEW OF ALL URANIUM MINING ACTIVITIES IN TURKEY SINCE 1957, WITH A DESCRIPTION OF THE MAIN DEPOSIT FOUND IN THE COUNTRY. Com. Naz. Energ. Nucl., Notiz.; 19: No. 2, 83-84(Feb 1973). (In Italian).

A review is presented of all uranium mining activities in Turkey since 1957, with a description of the main deposit found in the country. (auth)

18225 FOSSIL NUCLEAR REACTOR IN GABON. Vendryes, G. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Fr. Energ.; 24: No. 250, 182-185(Feb 1973). (In French).

The way in which the existence of a natural nuclear reactor was confirmed from isotopic anomalies encountered in uranium from Gabon is described. The scientific analysis of the phenomenon is presented. (FR)

18226 QUESTION OF WHETHER SOME OF THE NODULES OF MANGANESE FOUND AT THE SURFACE OF SEDIMENTS WERE FORMED AFTER SEDIMENTATION. Lalou, C. (CNRS, Gif-sur-Yvette, France); Brichet, E.; Ranque, D. Compt. Rend., Ser. D; 276: No. 11, 1661-1664(12 Mar 1973). (In French).

The discovery of a large excess of ^{230}Th in various parts of the nuclei of nodules in the Pacific Ocean prove that these nuclei have very recently been subjected to a very extensive modification that could only have taken place at the beginning of the formation of the manganese and iron oxide precipitates. (FR)

18227 AGE OF URANIUM MINERALISATION AT NABARLEK, NORTHERN TERRITORY, AUSTRALIA. Cooper, J. A. J. Geol. Soc. Aust.; 19: No. 4, 483-486(Jan 1973).

Discordant uranium–lead isotope measurements are reported for a sample of Nabarlek pitchblende. These are compared with earlier measurements on uranium minerals from the South Alligator River area. New interpretations suggest that regional uranium mineralization took place either 710 or 815 m.y. ago; the lower of these calculations is based on the assumption of modern episodic lead loss, and the higher assumes lead loss by continuous diffusion. (auth)

18228 MINERALOGY, FLUID INCLUSIONS, AND STABLE ISOTOPES OF THE ECHO BAY U–Ni–Ag–Cu DEPOSITS, NORTHWEST TERRITORIES, CANADA. Robinson, B. W. (Inst. of Nuclear Sciences, D.S.I.R., Lower Hutt, New Zealand); Ohmoto, H. Econ. Geol.; 68: No. 5, 635-656(Aug 1973).

The mineralization stages within veins of the Echo Bay mine are: 1. Quartz-hematite stage. 2. Pitchblende stage. 3. Co–Ni arsenides with native silver and bismuth stage. 4. Early acanthite stage. 5. Main sulfide and dolomite stage. (Within this stage, acanthite, chalcopyrite, bornite, sphalerite, and galena occur in up to three phases of mineralization.) 6. Late negative silver stage. 7. Mckinstryite stage. The temperature of mineralization suggested by the occurrence of native bismuth and mckinstryite, the fluid inclusion filling temperatures, the sulfur isotopic compositions of coexisting sphalerite and galena, and the oxygen isotopic compositions of coexisting quartz and hematite were: around 120°C for the first four stages, about 200°C for stages 5 and 6, and below about 95°C for the last stage. The original depth of of ore deposition suggested from the temperature and the stratigraphic data was between 2.5 and 4.5 km. The oxygen isotopic compositions of quartz, hematite, calcite, and dolomite samples, together with the temperature data, suggest that the oxygen isotopic composition of hydrothermal water was nearly constant throughout the entire depositional stages with $\delta^{18}O$ values of $+1.0 \pm 2.5$ ‰ (SMOW). These $\delta^{18}O_{H_2O}$ values suggest very little, if any contribution of magmatic water in the Echo Bay ore-forming fluids. The $\delta^{13}C$ values of dolomite and calcite of different stages are similar and within the range of -4 to -1.5 ‰ (PDB). However, the $\delta^{34}S$ values of the vein sulfides show a very large spread of ~50 ‰, with a definite trend of increasing $\delta^{34}S$ values toward later stage sulfides: from ca. -22‰ for the earliest sulfide (acanthite), ~-4 to ~$+20$‰ for stage 5 sulfides, to ca. $+27$‰ for the last stage sulfide (mckinstryite). This wide range in the $\delta^{34}S$ values of the hydrothermal minerals contrasts with the uniform $\delta^{34}S$ values ($+2$ to $+5$‰) of the pyrite in the host rock tuffs. (DHM)

18229 MINERALOGICAL CONSTITUTION AND ORIGIN OF THE URANIFEROUS DEPOSIT AT MOUNT MECSEK. II. Kiss, J. (Eoetvoes Lorand Univ., Budapest). Ann. Univ. Sci. Budapest Polando Eotvos Nominatae, Sect Geol., 14: 79-121(1971). (In French).

The enrichment of uranium in the Permian uraniferous mineral complex of Mount Mecsek exhibits, next to the uranium oxide detritus, an oxide and silicate sedimentary type, related principally to the epigenic micas (chromiferous and potassium-containing). The mode of appearance of the uranium minerals, the descending epigenic formations, and the pronounced presence of chromiferous and potassium-containing micas justify considering the uraniferous sandstone formation of Mount Mecsek as an independent type of sedimentary uranium mineral. Few similar deposits are known in the world literature. Uranium is accompanied in a remarkable way by the elements vanadium and germanium. As a result of this fact, the uraniferous deposit of Mount Mecsek has to be considered to be a deposit of the combined elements U–V–Ge. Since their concentrations are large (330 to 950 ppM for vanadium and 1 to 10 ppM for germanium), they can be explored in the future. The mineralogical form of vanadium and of germanium is ignored. The absence of an oxidation zone in the deposit and the sporadic presence of secondary uranium minerals are due to solutions of the hydrocarbonates of calcium and of magnesium and the reduced quantity of the ions PO_4^{3-}, AsO_4^{3-}, VO_4^{3-}, etc. The origin of the uraniferous deposit is twofold: it is formed from free uranium by the physicochemical decomposition of a formation of Bi–Co–Ni on the one hand, and from granitoid rocks and other metamorphic and magnetic rocks on the other, by precipitation in a reducing medium of the sedimentation from stagnant, marshy water in a delta. (tr-auth)

18230 URANIUM EXPLORATION MADE EASY. Gingrich, J. E. (Vallecitos Nuclear Generator, Pleasanton, CA). Power Eng.; 77: No. 8, 48-50(Aug 1973).

Dielectric strips can be planted at ground level to detect uranium ore bodies with a high degree of reliability, at low cost, and with near-zero impact on the environment. (auth)

Radioactive Effluents

Refer also to abstracts 20257 and 20266.

Radioactivity Monitoring and Transport

Refer also to abstracts 18460, 18533, and 18534.

18231 (LA-UR-73-1001) ECODISTRIBUTION OF PLUTONIUM IN LIQUID WASTE DISPOSAL AREAS AT LOS ALAMOS. Hakonson, T. E.; Johnson, L. J.; Purtymun, W. H. (Los Alamos Scientific Lab., N. Mex.). 1973. 23p. (CONF-730907-4). Dep. NTIS $3.25.

From 3rd international congress of the International Radiation Protection Association meeting; Washington, District of Columbia, USA (9 Sep 1973).

Surface and ground water samples were obtained at several locations in the Mortandad Canyon and alluvial sediments were collected using a core sampling device. Samples of the most abundant grasses, shrubs, and trees were collected at each sampling station. Snap traps were used for collecting small rodents. Tritium and ^{137}Cs concentrations were determined in all samples using liquid scintillation and gamma spectroscopic techniques. The plutonium content was determined using ion exchange separation, electrodeposition, and alpha spectroscopy. Tables are presented to show the $^{238}Pu/^{239}Pu$ ratios in water, sediment, vegetation, and rodents. The data show that the chronic input of low-level radioactive liquid wastes into Mortandad Canyon during the last ten years has resulted in plutonium concentrations

that were two to three orders of magnitude higher than those of pre-outfall samples. (HLW)

18232 RADIOLOGICAL SURVEILLANCE STUDIES AT A PRESSURIZED WATER NUCLEAR POWER REACTOR. Kahn, B.; Blanchard, R. L.; Kolde, H. E.; Krieger, H. L.; Gold, S.; Brinck, W. L.; Averett, W. J.; Smith, D. B.; Martin, A. Cincinnati; National Environmental Research Center (1971). 107p.

A program of studies conducted at commercial nuclear power stations to suggest surveillance guidelines is described. The studies are intended to provide the following information: identity and amount of radionuclides in effluents; influence of station operation on radionuclide discharges; degree of dispersion or concentration of radionuclides in the environment; relative importance of specific radionuclides and vectors in exposing population groups; magnitude of radiation exposure in the environment; and applicability of various monitoring and measuring techniques. Work performed at the Yankee Nuclear Power Station, a pressurized water reactor (PWR), is described. Yankee was built at Rowe, Massachusetts by the Westinghouse Electric Corp., and operates at a maximum power of 185 megawatts electric (MWe) and 600 thermal megawatts (MWt). It had produced more than 1×10^7 megawatt-hours between 1960 and 1969, and had passed through seven fuel cycles. The fuel is enriched (4.9 percent ^{235}U) uranium oxide (UO_2) pellets, clad in stainless steel. The study at Yankee followed one performed at the Dresden Nuclear Power Station, a boiling water reactor (BWR) that began operation in 1959 and has been producing power at a rated capacity of 210 MWe. At present, a study is in progress at one of the newer and larger PWR's, and one is being planned at a large new BWR. Many of the reported observations are applicable to planning radiological surveillance at the newer BWR's and PWR's. Caution should be exercised, however, in applying the reported discharge data to newer stations, because aspects of both design and operation tend to differ among stations. (CH)

Atmosphere

Refer also to abstract 18544.

18233 (LBL-1779) KRYPTON-85: A REVIEW OF INSTRUMENTATION FOR ENVIRONMENTAL MONITORING. Budnitz, R. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Apr 1973. Contract W-7405-eng-48. 18p. (CONF-730915-1). Dep. NTIS 13.00.

From symposium on noble gases; Las Vegas, Nevada, USA (24 Sep 1973).

Techniques developed for measuring krypton-85 in various media are reviewed. The main emphasis is on measurements for surveillance and protection in environmental situations, especially around nuclear reactors and nuclear fuel reprocessing plants. Measurements in specialized research applications are not treated in detail. Overviews are first provided of the physical characteristics of krypton-85; of the sources of and typical levels of concentrations in the environment; and of the radiation protection guides. The various measuring methods are then discussed, including the performance of liquid and plastic scintillators, Geiger–Mueller counters, and ionization chambers. (CH)

Water

Refer also to abstract 19867.

18234 (INS-593, pp 54-55) RADIOACTIVE FALL-OUT. Mason, W. J. Feb 1973.

In report on the work of the Institute of Nuclear Sciences. Progress Report 20.

18235 ABSORPTION OF YTTRIUM-91, NIOBIUM-95, AND CERIUM-141 BY SUSPENSION AND BOTTOM DEPOSITS OF THE INDIAN OCEAN. Gromov, V. V.; Surikov, V. V.; Bogdanov, Yu. A. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 834-838(1972).

Translated from Radiokhimiya; 14: No. 6, 805-809(1972).

The adsorption capacity of the bottom deposits and surface suspension, collected in different portions of the Indian Ocean, was investigated. It was established that various groups of sorbents studied can be arranged in the following series according to the degree of their absorptive capacity: bottom deposits, Foraminifera > surface suspension > zooplankton. It was found that niobium-95, in contrast to cerium-141 and yttrium-91, is sorbed most completely by carbonate or weakly carbonate sediments. On the other hand, regardless of the nature of the sorbent, radiocerium is absorbed most effectively from sea water ($K_d > 10^6-10^7$). (auth)

Ecosystems and Food Cycles

Refer also to abstracts 18245, 18576, 20612, and 20653.

18236 (EUR-3945(Pt.3)) COMPARISON OF THE RADIOACTIVE CONTAMINATION OF THE TOTAL DIET OF ADOLESCENTS IN THE COMMUNITY. III. Analysis of Food Consumption in the Institutional Diet Programme. Lanzola, E.; Marinoni, A. (Pavia Univ. (Italy). Istituto d'Igiene). Jun 1973. 31p. Dep. NTIS (U. S. Sales Only) $3.75. EUR B.Fr. 50.-.

Data collected during an investigation into the degree of radioactive contamination of the total diet of young people in the six Community Countries were used to evaluate the consumption of food by adolescents. The following eight groups of food were taken into consideration: milk, cheese, cereals and cereal products, potatoes, other vegetables, meat, and fish. From the consumption of these products, and the intake of calories, proteins, lipids, and calcium were calculated. (CH)

18237 (EUR-4965) RAPID DETERMINATION OF RADIONUCLIDES IN MILK. Results of an Intercomparison Organized Jointly by the I.A.E.A. and C.E.C. in 1972. Suschny, O.; Heinonen, J.; Merten, D.; Smeets, J.; Amavis, R.; Bonini, A. (International Atomic Energy Agency, Vienna (Austria). Div. of Research and Labs.; European Communities, Luxembourg. Commission). May 1973. 45p. Dep. NTIS (U. S. Sales Only) $4.25. EUR B.Fr. 60.-.

The problems posed by the rapid assessment of radioactive contamination of milk are very important in view of public health protection, particularly in the case of uncontrolled discharges of radioactive substances. For this reason the I.A.E.A. and C.E.C. have prepared and implemented jointly an intercomparison program to cover this field. The following radionuclides have been analyzed for two levels of contamination: strontium-89, strontium-90, iodine-131, cesium-137, barium-140. The results obtained by the 34 participating laboratories have shown that it is possible to provide the responsible authorities with sufficiently accurate information to permit them to make decisions on measures for protection of the population against ionizing radiation. (auth)

18238 STRONTIUM-90 IN THE EXOSKELETAL OSSICLES OF DASYPUS NOVEMCINCTUS. Jackson, C. G. Jr.; Holcomb, C. M.; Jackson, M. M. (Mississippi State Coll. for Women, Columbus). J. Math. Mech.; 53: No. 4, 921-922(Nov 1972).

Bone ash was prepared from exoskeletal ossicles of armadillos (Dasypus novemcinctus) and analyzed for ^{90}Sr. A table is presented to show ^{90}Sr burdens of eleven individuals from the southeastern states. The burdens of all but two individuals exceeded those for skeletons of black-tailed jackrabbits at the Nevada Test Site. The ^{90}Sr burdens were similar to those of the terrestrial gopher tortoise. (HLW)

18239 REDUCTION OF CESIUM-137 BODY BURDEN IN THE LABORATORY RAT. Spaulding, L. B. Albuquerque, NM; Univ. of New Mexico (1972). 151p. University Microfilms Order No. 73-14,361.

Thesis (Ph. D.).

Variations of peritoneal dialysis, drinking solution, and temperature were used alone or in combination to study tissue accumulation, percentage reduction of initial whole body burden, and biological half-lives of cesium-137 in the laboratory rat, Rattus norvegicus. Routes of administration (intra-arterial or intraperitoneal), time interval between injection of cesium-137 and onset of peritoneal dialysis, rapid or slow drainage of dialysate, and composition of the dialysate were treatments examined. Peritoneal dialysis reduced the whole body burden compared to nondialyzed animals. Route of administration, time interval between injection and dialysis, and the dialysis procedure itself were important factors in determining tissue accumulation as well as reduction of initial whole body burden. The data indirectly supported the hypothesis that at later periods of time cesium-137 was included in the cellular elements and bound to protein. The effects of drinking solutions (Prussian blue, α-ketoglutarate, sodium chloride, sodium glutamate, and distilled water), ambient temperature (22 and 5°C), and peritoneal dialysis on tissue accumulation, first and second biological half-lives ($BT_{\frac{1}{2}}$), and over-all urine to feces ratios were also studied. Drinking solutions, cold exposure, and dialysis changed the first and second $BT_{\frac{1}{2}}$ and over-all urine to feces ratios but did not change tissue retention indices (TRI = cpm/g tissue per cpm/g whole animal) of cesium-137. In earlier studies, Prussian blue appeared to enhance cesium-137 excretion by reducing the enteral circulation of radiocesium. In this study Prussian blue and 5°C ambient temperature both increased cesium-137 excretion but combining these two treatments resulted in a synergistic response. Drinking solutions of α-ketoglutarate increased cesium-137 excretion at 5°C but

decreased its excretion at 22°C. Sodium chloride solution increased excretion via urine and lowered first and second $BT_{\frac{1}{2}}$ at 5°C. Sodium glutamate enhanced cesium-137 excretion by urine at 22°C and lowered the first and second $BT_{\frac{1}{2}}$. Decreasing the temperature from 22 to 5°C increased the oxygen consumption by 42.5% and lowered the first $BT_{\frac{1}{2}}$ by 39.2% for animals drinking distilled water. Peritoneal dialysis 1 hr after intraperitoneal injection shortened first and second $BT_{\frac{1}{2}}$, which were then comparable to continuous treatment with Prussian blue. (Diss. Abstr.)

Radiometric Techniques

18240 (CONF-700705-(Vol.2), pp 535-542) KINETICS OF FISSION TRACK DISAPPEARANCE IN MUSCOVITE MICA. Brito, U.; Lalou, C. (Centre National de la Recherche Scientifique, Gif-sur-Yvette, France). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

It has been possible to show that fission tracks in muscovite mica present two types of defects that have different activation energies (0.4 and 0.7 eV) and that these two types of defects can coexist in the same track. Furthermore, it has been seen that annealing delays the appearance of the first tracks and modifies the speed of revelation, which should make it possible to estimate, qualitatively, whether a sample of rock has been heated or not. Furthermore, annealing even at a temperature as low as 80°C during one hour gives a decrease in the total number of tracks of about 5% and for 150°C this decrease reaches 22%. The results ought to make it possible to establish a method for the correction of the age of rocks that have been subjected to thermometamorphosis. (tr-auth)

18241 (INIS-mf-529) APPLICATION OF RADIATION TECHNIQUES IN WATER-USE EFFICIENCY STUDIES. Report to the International Atomic Energy Agency. Hillel, D. (National and Univ. Inst. of Agriculture, Rehovoth (Israel)). Nov 1971. Contract 328/RB. 87p. INIS.

The objective of this report is to obtain comparative data on the field water balance and evapotranspiration under different irrigation regimes and climatological conditions by: (a) weighing lysimeters; (b) monitoring soil moisture changes with a neutron meter; (c) agrometeorological methods. The site chosen has been the arid zone of Israel and the research was carried over a period of 5 years. (INIS)

18242 (STI/PUB-21/41) ISOTOPE TECHNIQUES IN HYDROLOGY. Vol. II. (1966–1971). Bibliographical Series No. 41. (International Atomic Energy Agency, Vienna (Austria)). 1973. 238p. IAEA $9.00.

Eight-hundred and fourteen references are presented to the world literature on isotope techniques in hydrology. Abstracts are included for most of the references that report the use of radioisotopes released to the environment in fallout or radioactive liquid wastes, as well as those naturally occurring, as tracers for measurements of water flow; the development of radiometric instruments; and radiometric techniques. Author and keyword indexes are included. (CH)

Site Surveys

Refer also to abstracts 20427 and 20537–20539.

18243 (DOCKET-700371–2) NAVAL PRODUCTS DIVISION. Environmental Report, Revised (7-23-73). (United Nuclear Corp., New Haven, Conn.). 23 Jul 1973. 176p. Dep. NTIS $11.00.

The revised sections of the Environmental Report for Naval Products division of United Nuclear Corporation are presented. The sections included are hydrology; effects of human activities in the environment; resource use under buildings and site changes resulting from plant expansion and consolidation; environmental effects of plant operation; serious fire or explosion within a facility under class 4 accidents; major fire or explosion under class 5 accidents; gas cloud doses for thyroid dose and uranium lung dose under class 6 accidents; plant operation under unavoidable effects of plant expansion operation; biodegradeable liquid wastes, nonbiodegradeable liquid wastes, and gaseous radwaste disposal under benefit cost analysis; and regulatory agency approvals/permits. (DHM)

18244 (PRNC-162) AGUIRRE POWER PROJECT ENVIRONMENTAL STUDIES 1972 ANNUAL REPORT. (Puerto Rico Nuclear Center, San Juan). Mar 1973. Contract AT(40-1)-1833. 264p. Dep. NTIS $15.25.

Results of an ecological site survey at the Puerto Rico Nuclear Center are reported under the following headings: plankton of Jobos Bay; foraminifers from Jobos Bay; report on algae of Jobos and Guayanilla Bays; ecology of turtle grass (Thalassia testudinum) beds in Jobos Bay; ecology of sessile and free-living organisms on mangrove roots in Jobos Bay; the zonation and ecology of the Jobos Bay coral reefs; the distribution and ecology of the fishes of Jobos Bay; and bird fauna of Jobos Bay: 1972 census. (HLW)

18245 (UCLA-12-916) SOME CHARACTERISTICS OF SOIL AND PERENNIAL VEGETATION IN NORTHERN MOJAVE DESERT AREAS OF THE NEVADA TEST SITE. Romney, E. M.; Hale, V. Q.; Wallace, A.; Lunt, O. R.; Childress, J. D.; Kaaz, H.; Alexander, G. V.; Kinnear, J. E.; Ackerman, T. L. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Jun 1973. Contract AT(04-1)-Gen-12. 340p. Dep. NTIS $10.60.

Data were compiled from several interrelated projects conducted at the Nevada Test Site as part of a team effort to obtain more information on soil and plant relationships in the desert ecosystem in order to better understand the impact of nuclear testing on the environment. It ties together the masses of acquired data into one convenient volume for use by the funding agency and also to serve as a basis for the continuing systems analysis work involved with these projects. Included are results from the chemical and physical characterization of soil profiles at 79 study sites located in some northern Mojave Desert areas of the Nevada Test Site. These profiles were characterized under clumps of perennial vegetation and under bare desert pavement in order to determine the modifying influence of shrubs on desert soil. Ecological attributes of perennial vegetation determined by nondestructive, dimensional analysis are reported in terms of density, area, volume, and biomass according to the existence of shrubs as solitary plants or as members of a shrub clump. Mineral element compositions of leaves and stems are reported for the most common plant species at each study site. Also included are the concentrations of ^{137}Cs, and the natural ^{40}K (as total K), uranium, and thorium found in the surface fractions of the soil profile. Abiotic data compiled during a five year period from nine sampling stations are reported for rainfall, air temperature, soil temperature and soil moisture. (auth)

Thermal Effluents

Refer also to abstracts 20286 and 20545.

18246 (ORNL-NSIC-110) INDEXED BIBLIOGRAPHY OF THERMAL EFFECTS LITERATURE-3. Morgan, J. G. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 230p. Dep. NTIS $12.00.

Chemical Effluents

Refer also to abstracts 17850 and 20632.

18247 (UCLA-34-P-134-7) BIOLOGICAL CYCLING OF ELEMENTS AND STABLE ISOTOPES IN MARINE ENVIRONMENTS. Progress Report, April 1, 1972–May 1, 1973. Kaplan, I. R. (California Univ., Los Angeles). 1973. Contract AT(04-3)-34. 247p. Dep. NTIS $14.50.

Progress is reported in studies on the biological cycling of elements and stable isotopes in marine environments. A neutron activation method for the rapid measurement of total uranium content in marine sediments is described. Other studies reported include the anaerobic degradation of organic matter on the sea floor; an evaluation of the magnitude of ionic diffusion constants in marine sediments; and the development of a rapid monitoring system for dissolved sulfate in seawater and sediments for use in evaluation of the pollution of the ocean floor. A list of papers accepted for publication during the period covered by this report is included. (CH)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 18219 and 18583.

General Detectors and Monitors

Refer also to abstracts 17997, 18233, 19824, 20289, and 20294.

18248 (BNWL-SA-4681) LUNG COUNTER CALIBRATION AT BATTELLE–NORTHWEST. Mayfield, D. L.; Walsh, W. P. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. 33p. (CONF-730439-1). Dep. NTIS $3.75.

From workshop on the in-vivo measurements of heavy elements; Los Alamos, New Mexico, USA (24 Apr 1973).

The whole-body counters and the lung counter in routine use at Battelle–Northwest are briefly described, and calibration procedures are discussed. The whole-body counters are calibrated semiannually with a polyethylene bottle phantom, and the lung counter is calibrated semiannually with a tempered masonite projection phantom. Calibration curves are given. (WHK)

18249 (CONF-700705-(Vol.1)) 7TH INTERNATIONAL CONFERENCE ON CORPUSCULAR PHOTOGRAPHY AND SOLID VISUAL DETECTORS. Volume 1. Conference Held in Barcelona, Spain, July 7–11, 1970. Cuer, P.; Schmitt, R. (eds.) (Centre National de la Recherche Scientifique, Strasbourg (France). Laboratoire de Physique Corpusculaire). 1970. 432p. (In French and English).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Separate abstracts were prepared for 37 of the 38 papers presented. One paper was previously abstracted in NSA (25: 13209). (WHK)

For abstracts of individual papers see: 18250–18273, 18357–18366, 19262, 19819, and 19820.

18250 (CONF-700705-(Vol.1), pp 49-57) EMULSION LAYERS WITH INCREASED HYDROGEN CONTENT FOR IRRADIATION IN STRONG MAGNETIC FIELDS. Tretyakova, M. I. (Lebedev Inst. of Physics, Moscow); Chernyavskii, M. M.; Bogomolov, C. S.; Mylzeva, V. A.; Okuneva, O. I.; Bokova, L. I.; Lyubomilov, S. I.; Baranov, V. I. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Characteristics of emulsion layers BR × 2y, BR × 3y, BR × 4y with increased hydrogen content and a shrinkage factor of 2.5 are given. Thickness of layers is 600 to 700 μ. The density of relativistic particles tracks in layers BR × 4y is about 18/100 μ when processed coated on glass. (auth)

18251 (CONF-700705-(Vol.1), pp 71-74) PROCESSING OF THIN EMULSIONS. Medveczky, L. (Inst. of Nuclear Research, Debrecen, Hungary). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Various processing procedures for 50 μm thick Ilford G5 plates used in magnetic beta spectrographs are described and results are presented. (WHK)

18252 (CONF-700705-(Vol.1), pp 75-82) ELECTRON MICROSCOPE OBSERVATION OF TRACKS OF CHARGED PARTICLES REGISTERED IN IONOGRAPHIC EMULSIONS. Schmitt, R.; Demoulin, R.; Strebel, N. (Centre de Recherches Nucleaires, Strasbourg). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The method of electron microscope observation of tracks in ionographic emulsions is too restricted to be of general use, but it could become irreplaceable in certain specific studies such as in the study of particles with very short lives such as hyperfragments or of particles of low energy that produce short tracks, such as recoil nuclei, or even a better discrimination of heavy ion tracks. (tr-auth)

18253 (CONF-700705-(Vol.1), pp 89-106) SOLID STATE PRECIPITATION DETECTORS: NUCLEAR TRACKS IN SILVER HALIDE SINGLE CRYSTALS. Haase, G.; Schopper, E.; Henig, G.; Schott, J. U.; Zoergiebel, F. (Univ., Frankfurt am Main). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

In certain solid systems the disturbances, originating from the interaction of a charged nuclear particle on its path, can be used to initiate the precipitation of a new phase in the system, which leads to a visible track of the particle. The mechanism is briefly discussed. Well-known representatives of such systems are the silver halides, in particular silver chloride single crystals. The properties of these detectors and their response to ionizing particles strongly depend on impurities or on particular doping components respectively. A special procedure of growing thin sheets of AgCl monocrystals permitted to investigate a large amount of various elements, among which Cd and Pb proved favorable. The response of AgCl crystals as a function of the doping concentration, and the influence of temperature onto the sensitivity and the stability of tracks are discussed as well as the simple procedure of revealing of the tracks by ultraviolet light. Examples of tracks and of applications are given. As an outlook from preliminary results the facility is mentioned to make visual precipitation detectors in which the latent tracks are rapidly fading and can be revealed only by immediate triggering. Finally, the precipitation procedure for recording nuclear tracks seems to be realizable also with specially doped glasses. First results are encouraging. (auth)

18254 (CONF-700705-(Vol.1), pp 107-115) SOLID STATE PRECIPITATION DETECTORS FOR NUCLEAR TRACKS: PROBLEMS IN PRODUCING AgCl SINGLE CRYSTAL SHEETS. Haase, G.; Schopper, E.; Henig, G.; Schott, J. U.; Zoergiebel, F. (Univ., Frankfurt am Main). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A method for growing AgCl single crystal sheets with an area of about 1 cm^2 for use as nuclear track detectors is described. (WHK)

18255 (CONF-700705-(Vol.1), pp 117-119) DETECTION OF FISSION FRAGMENT TRACKS IN CRYSTALLINE QUARTZ: UTILIZATION IN NUCLEAR PHYSICS. Sowinski, M. (Institut de Physique Nucleaire, Orsay, France); Stephan, C.; Czyzewski, T.; Tyz, J. 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The crystal is polished in a potassium hydroxide bath at 200°C and then track etching is accomplished in a sodium carbonate solution (75 g Na_2CO_3/100 cc H_2O) at 120°C for 2 hours. Track parameters including size and effects of angle of incidence are discussed. It is stated that synthetic crystalline quartz is best adapted for use as a detector containing the least possible amount of uranium in the search for superheavy elements by neutron-induced fission fragment detection. (WHK)

18256 (CONF-700705-(Vol.1), pp 121-126) DETERMINATION OF THE LENGTH OF ETCHED LOW ENERGETIC HEAVY ION TRACKS IN QUARTZ GLASS BY MEANS OF AN INTERFERENCE TECHNIQUE. Kraetschmer, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Quartz glass was bombarded with various heavy ions (Cl, Fe, Br, I, U) in the energy range between 10 and 100 MeV. Under fixed etching conditions the lengths of the particle tracks were measured as a function of particle energy. The track lengths were determined from the interference pattern of the etchpits using a reflection interference microscope. By this technique an energy resolution of ±2 MeV in the investigated energy region was achieved. For Br and heavier ions it was found that above 30 MeV the track length is a linear function of particle velocity. Combined with diameter measurements, the track length gives information about nuclear charge and energy of the track forming particle. (auth)

18257 (CONF-700705-(Vol.1), pp 127-146) CHEMICAL DEVELOPMENT OF TRACKS IN ORGANIC NUCLEAR TRACK DETECTORS. Benton, E. V. (Univ. of San Francisco). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

In recent years organic nuclear track detectors have found wide application in several different scientific fields including physics, geophysics, and biophysics. They are utilized for the selective recording of very heavily ionizing, energetic, charged particles. Particle tracks are observed after a chemical etching treatment of the irradiated detectors. This serves to enlarge the particle damage trails to optically visible dimensions. A variety of chemical etchants and techniques have been proposed and utilized. The most commonly used of the chemical etchants, as utilized with the most important track detecting materials,

are reviewed. For track development, the etchant must have access to the latent track region. Since etchants do not readily diffuse through the bulk material, only latent tracks that cross the detector surface are developed. For certain applications this has been a serious shortcoming. A technique is presented which allows the development of tracks within the volume of the detector. This technique will be useful in a variety of applications that require the visualization of complete sets of tracks (such as nuclear "stars"), or visualization of tracks deep in the detector volume away from external surfaces. The increased number of visible tracks will in turn result in the enhancement of detector sensitivity, i.e., make possible the measurement of infrequently occurring events. (auth)

18258 (CONF-700705-(Vol.1), pp 147-168) SOME RECENT IMPROVEMENTS IN OUR EXPERIMENTAL UNDERSTANDING OF THE INTERACTION OF CHARGED PARTICLES WITH PLASTIC DETECTORS. Some Applications at the Laboratoire de Physique Corpusculaire de Strasbourg. Debeauvais, M.; Ralarosy, J.; Remy, G.; Stein, R.; Tripier, J. (CNRS, Strasbourg). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The study of heavy ion tracks using an electron microscope and an optical microscope is discussed; and track parameters such as specific energy loss, range, and development parameters are considered. The uses of plastic track detectors for dosimetry and for studying very heavy element fission induced by high-energy protons are discussed. Specific energy losses as a function of energy are given for sulfur and oxygen ions; the variation of the speed of development of Makrofol for different ions as a function of specific energy loss is shown graphically; a comparison of track lengths of different ions of different energies as a function of time of development is given; the ranges of different ions of different energies are plotted; and specific energy loss is plotted as a function of energy per nucleon for different ions. (WHK)

18259 (CONF-700705-(Vol.1), pp 169-173) UTILIZATION OF POLY(VINYL CHLORIDE) AS SOLID TRACK DETECTOR. Monnin, M.; Montret, M.; Sanzelle, S.; Touzery, C. (Laboratoire de Physique Nucleaire Fondamentale et Developpement, Clermont-Ferrand, France). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The effects of various additives (lead salts, tin salts, and mixed barium cadmium salts) on the track etching time and the performance for fission fragment detection are studied. Data are given. (WHK)

18260 (CONF-700705-(Vol.1), pp 175-180) INFLUENCE OF HUMIDITY ON TRACK REGISTRATION IN CELLULOSE NITRATE PLASTIC DETECTORS. Enge, W.; Beaujean, R.; Nicken, H. P. (Univ., Kiel). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Daicel cellulose nitrate has been exposed to vertically incident alpha particles up to 5 MeV to study the influence of water on the etching process in 6N NaOH at 50°C. For this purpose two sets of samples exposed to alpha particles were studied, one was rinsed in 50°C hot water for 20 minutes immediately before etching, while the other one was kept dry. The track etching rate v_t and the bulk etching rate v_b of the "wet" samples grew to twice the rates of the "dry" samples. As the ratio v_t/v_b remained constant, there is no improvement of the sensitivity of the track registration; however, great attention has to be kept on this effect of the water on the etching process when precise etching is required. (auth)

18261 (CONF-700705-(Vol.1), pp 181-185) IMPROVEMENT IN PARTICLE TRACK ETCHING IN LEXAN POLYCARBONATE FILM. Peterson, D. D. (General Electric Research and Development Center, Schenectady, NY). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

An improvement in the process of particle track etching in Lexan polycarbonate film has been made leading to smoother track profiles. The improvement is based on the findings that in aqueous sodium hydroxide, the bulk etching increases with an increase in the concentration of etch products in solution. The rate reaches a maximum value at the etch product solubility limit, and remains at this value in the presence of etch product precipitation. Using an etchant saturated with etch products, the track profile is smooth compared with the irregular profile obtained with an unsaturated etchant. Alternatively, the saturated etchant can be prepared by adding the compound Bisphenol A to aqueous sodium hydroxide. Using a saturated etchant, the etched track length (L) is given by $L \sim R^{-\alpha}$, where R is the residual range and $\alpha \approx 1$, for heavy cosmic rays that come to rest in a stack of thin Lexan films. (auth)

18262 (CONF-700705-(Vol.1), pp 187-204) IMPROVEMENT OF THE PERFORMANCE OF CELLULOSE NITRATE FILM FOR RECORDING IONIZING PARTICLE TRACKS. Barbier, J. F. 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A study of the anomalies in different cellulose nitrate track detectors and the development of detectors with more reproducible results are discussed. Characteristics of cellulose nitrate track detectors, track etching, and cellulose nitrate detectors for neutron radiography and thermal neutron dosimetry using lithium converter foils are discussed. (WHK)

18263 (CONF-700705-(Vol.1), pp 205-211) COMPARATIVE STUDY OF THE EFFECTS OF THE GASES ON DETECTION CHARACTERISTICS. Chave, A.; Monnin, M. (Laboratoire de Physique Nucleaire Fondamentale et Developpement, Clermont-Ferrand, Franc). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The effects of various gases on track formation in poly(vinyl chloride) and polycarbonate track detectors for fission fragment detection were studied. The effects of gaseous atmospheres of SO_2, N_2O, NO, and I_2 were studied and results are given. (WHK)

18264 (CONF-700705-(Vol.1) pp 213-231) ELECTROCHEMICAL ETCHING OF DAMAGE TRACK DETECTORS BY PULSE AND SINUSOIDAL WAVEFORMS. Tommasino, I. (CNEN, Rome). 1970.

From 7th international conference on corpuscular photography and visual solid detectors, Barcelona, Spain (7 Jul 1970).

An electrochemical etching process for increasing the sensitivity of dielectric track detectors is described. The irradiated plastic foil is placed between two Teflon cells containing etching reagent, usually 30% KOH in water. The output of the high-voltage function generator, which gives sinusoidal or positive square pulse waveforms is applied through the irradiated dielectric by two platinum electrodes placed directly in the reagent. Results are discussed. (WHK)

18265 (CONF-700705-(Vol.1), pp 219-231) RESPONSE OF CELLULOSE NITRATE TO LITHIUM AND OXYGEN IONS IN DIFFERENT ENERGY RANGES. Pfohl, R. (CNRS, Strasbourg); Kaiser, R.; Schmitt, R.; Rios, C.; Gandia, V. 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The detection of lithium-6 ions at 6 to 12 MeV at 15 to 30°C, lithium-7 ions at 12 to 20 MeV, and oxygen-16 at 33 to 52 MeV at 45°C using cellulose nitrate track detectors was studied. Results are presented and discussed. (WHK)

18266 (CONF-700705-(Vol.1), pp 233-237) MEASUREMENTS OF ISOTOPES IN CELLULOSE NITRATE PLASTIC DETECTORS. Beaujean, R.; Enge, W. (Univ., Kiel). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

To calibrate a large area stack of plastic detectors flown in Ft. Churchill to measure cosmic rays, small stacks of the same material (Daicel cellulose nitrate) were exposed to ^{10}B, ^{11}B, and ^{12}C ions of the Yale Heavy Ion Accelerator. After etching these stacks at 50°C in a 6N NaOH solution, the track lengths as a function of the residual range were measured. It is shown that in the case of small calibrated sheets, a mass resolution between ^{10}B and ^{11}B is possible. The track etching rate of Daicel cellulose nitrate is presented. (auth)

18267 (CONF-700705-(Vol.1), pp 239-258) METHOD FOR MEASURING THE BEAM PROFILES OF HIGH-INTENSITY PARTICLES ($10^{12}/cm^2$). Annoni, H. (CNRS, Strasbourg); Oppel, R.; Cordaillat, A.; Herz, A. J.; Mendola, O. 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

This method allows a rapid and precise determination of the beam profile, the position of the maximum of the intensity and the absolute intensity (with an error of about 10%). At present, it can be used for intensities between 10^{11} and 2×10^{12} particles/cm^2. Thin plastic detector foils (cellulose nitrate) are exposed normal to the beam under study and the measurements are carried out with a microdensitometer. Nuclear-research emulsions have been used as a comparison standard. The first measurements were carried out in a proton beam of energy 600 MeV; the method can, of course, be applied to any other kind of high-intensity, high-energy beam. (auth)

18268 (CONF-700705-(Vol.1), pp 263-266) DIFFICULTIES IN THE EXPOSURE OF PLASTIC DETECTORS IN A VACUUM CHAMBER: METALLIZATION. Cordaillat, A. (CERN, Geneva); Annoni, H. 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Experiments on metallization of plastic detectors (cellulose nitrate and Makrofol) hindering degassing, were carried out with the view of using such detectors in an enclosure under vacuum. These investigations require a preliminary corrosion of the surface of the detector and a cleaning after use. These two operations have to be carried out without harm both to the registration of tracks as well as to the development of plastic detectors. (tr-auth)

18269 (CONF-700705-(Vol.1), pp 267-275) RECORDING OF α PARTICLE TRACKS IN CELLULOSE NITRATE AND POSSIBLE UTILIZATION. Nicolae, M. (Inst. for Atomic Physics, Bucharest). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A study of the preparation, treatment, and characteristics of registration of alpha particle tracks in cellulose nitrate is given. The detector was etched in sodium hydroxide. The efficiency for detection of americium-241 alpha particles is given for different etching temperatures and times. The specific ionization loss and critical energy for alpha particles is given. The use of cellulose nitrate track detectors for radon dosimetry and for neutron dosimetry based on recoil or reaction product detection is suggested. (WHK)

18270 (CONF-700705-(Vol.1), pp 277-285) DETECTION OF α PARTICLES IN POLYMERS. Dutrannois, J. (CERN, Geneva). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The enhancement of α particle tracks in Makrofol track detectors based on an ozone treatment prior to etching is described. The detector is treated in a water-saturated mixture of ozone (20%) and oxygen. (WHK)

18271 (CONF-700705-(Vol.1), pp 287-296) MECHANISM OF CELLULOSE FILMS SENSITIVITY TO IONIZING PARTICLE TRACKS REGISTRATION. Veprik, Ya. M.; Kartuzhnskii, A. L.; Marennyi, A. M.; Popov, V. I. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Characteristics of nitrate cellulose and acetate cellulose track detectors are discussed and compared. The radiation chemistry of the track formation in polymers is discussed and the necessity of the presence of oxygen for good sensitivity is explained. (WHK)

18272 (CONF-700705-(Vol.1), pp 339-346) MEASUREMENT OF MULTICHARGED, LOW ENERGY, PRIMARY COSMIC RAY PARTICLES ABOARD APOLLO. Benton, E. V.; Henke, R. P. (Univ. of San Francisco). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Measurements have been made of the multicharged ($Z \geq 10$), low energy ($\lesssim$200 MeV/nucleon), primary cosmic particles during the lunar and earth orbital flights of the Apollo. The detectors consist of either two or three layers of Lexan plastic, making up the total collecting area of about 100 cm^2 per flight. Preliminary results of Apollo VIII-X flights are presented. (auth)

18273 (CONF-700705-(Vol.1), pp 365-384) STUDIES OF COSMIC RADIATION AND FRAGMENTATION REACTIONS CARRIED OUT WITH VISUAL DETECTORS. Schmitt, R. (CNRS, Strasbourg). • 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Topics include cosmic particle track discrimination owing to measurements of granularity, discrimination of relativistic tracks using absorbers and particle separation using superconducting magnetic fields. Also, fragmentation of cosmic ions, spallation reactions in ionographic emulsions, and spallation reactions in homogeneous targets are discussed. (TSS)

18274 (CONF-700705-(Vol.2)) 7th INTERNATIONAL CONFERENCE ON CORPUSCULAR PHOTOGRAPHY AND VISUAL SOLID DETECTORS, BARCELONA, SPAIN, JULY 7–11, 1970. Cuer, P.; Schmitt, R. (eds.) (Centre National de la Recherche Scientifique, Strasbourg (France). Laboratoire de Physique Corpusculaire). 1970. 444p. (In French).

Separate abstracts were prepared for 43 of the 47 papers presented. The remaining 4 papers were previously abstracted in NSA (23: 49028, 24: 36167, 26: 14608, and 26: 15244). (WHK)

For abstracts of individual papers see: 18223, 18240, 18275–18301, 18329, 18330, 18348, 18367, 19186–19190, 19821, 19822, 19883, 19957, and 19958.

18275 (CONF-700705-(Vol.2), pp 441-446) MEASUREMENTS OF ^{4}He PARTICLES AND RECOIL NUCLEI PRODUCED BY HIGH ENERGY NEUTRONS IN PLASTICS. Frank, A. L.; Benton, E. V. (Univ. of San Francisco). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Plastic nuclear track detectors are being developed for the selective detection of high-energy neutrons (>10 MeV). Spectral information on high energy neutrons is obtained from measurements of ^{4}He particles from (n,α) reactions, elastically scattered recoil nuclei, and the characteristic manner in which track densities change with absorber thickness. (auth)

18276 (CONF-700705-(Vol.2), pp 447-460) HEAVY ION DOSIMETRY BY NUCLEAR EMULSIONS. Nicolae, M.; Haseganu, D. (Inst. of Atomic Physics, Bucharest). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A method for the discrimination of heavy ions in nuclear emulsions is described. Different stacks of nuclear emulsions exposed simultaneously are developed differently to divide the ion spectrum into ionization groups. Results are presented. (WHK)

18277 (CONF-700705-(Vol.2), pp 461-468) SOLID STATE PRECIPITATION DETECTORS FOR NUCLEAR TRACKS. III. Some Applications of AgCl-Detectors. Schopper, E.; Schott, J. U.; Henig, G.; Haase, G.; Palm, E.; Zoergiebel, F. (Univ., Frankfurt am Main). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Some characteristics and uses of monocrystalline AgCl(Cd) track detectors in fission experiments are described. Particle discrimination properties are graphically depicted of the response of AgCl(Cd) detectors to particles of different specific ionization as a function of their cadmium content. Use for measuring the mean-life of the isomeric fissioning decay of plutonium-240 is described. (WHK)

18278 (CONF-700705-(Vol.2), pp 469-479) ABSOLUTE SLOW NEUTRON MEASUREMENTS WITH SOLID STATE TRACK RECORDERS. Congel, F. J. (Macalester Coll., St. Paul); Roberts, J. H.; Armani, R. J.; Gold, R.; Kastner, J.; Oltman, B. G. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

High accuracy (~1%) in the measurement of absolute slow neutron fluxes can be obtained by the well-established method of gold foil activation. It has been shown that measurements with mica as a recorder of slow-neutron induced fission events from thick (0.125 mm) natural uranium or thin (<100 μgm/cm^2) enriched uranium (93.2% ^{235}U) provide comparable accuracy. The technique is also applicable to much lower neutron fluxes. It is also shown that background-free mica can be obtained by annealing muscovite in a furnace at 580°C for about 24 hours and then etching it in 49% HF at room temperature for 24 hours. Studies of the electronic track counting method of Cross and Tommasino are also reported. This method looks promising for the measurement of extremely small neutron fluxes. (auth)

18279 (CONF-700705-(Vol.2), pp 481-487) YIELD OF TERNARY FISSION OF ^{236}U INDUCED BY THERMAL NEUTRONS. Juric, M.; Antanasijevic, R.; Vukovic, J. (Inst. of Physics, Belgrade). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A comparison is made of data on ternary fission of ^{236}U induced by thermal neutrons obtained by the use of photonuclear emulsions with those obtained by the use of solid-state track detectors. The frequency of ternary fission of ^{236}U is determined as compared to the binary fission. (auth)

18280 (CONF-700705-(Vol.2), pp 489-494) DETERMINATION OF THE MASSES AND THE ENERGIES OF FISSION FRAGMENTS FROM ^{232}Th WITH A MICA DETECTOR. Casanova, J.; Nalda, J.; Valle, J. (Univ., Valladolid, Spain). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Mica solid-state track detectors for determination of mass and energy distribution in the reaction ^{232}Th (n,f) at E_n = 14.1 and 4.5 MeV is studied, as well as the total cross section of this reaction. (auth)

18281 (CONF-700705-(Vol.2), pp 495-502) APPLICATION OF SOLID STATE TRACK RECORDERS IN ABSOLUTE FISSION PRODUCT YIELD MEASUREMENTS. Armani, R. J. (Argonne National Lab., IL); Gold, R.; Larsen, R. P.; Roberts, J. H. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

With the development of the solid state track recorder (SSTR) method for precise fission rate measurements, a simple direct

method for measuring fast fission yields is now available. Measurements can be carried out at relatively low neutron fluences. Fission product yields of ^{99}Mo and ^{140}Ba from ^{239}Pu(n,f) have been measured in the fast neutron spectrum of a low power reactor. Radiochemical techniques and radioactivity measurements were used to determine the amounts of ^{99}Mo and of ^{140}Ba produced through the irradiation of plutonium foils. The value found for the fast fission yields of ^{99}Mo and of ^{140}Ba are (0.0580 ± 0.0005) and (0.0500 ± 0.0006), respectively. (auth)

18282 (CONF-700705-(vol.2), pp 521-526) ANALYSIS OF THE ETCH PIT SIZE DISTRIBUTION IN MAKROFOL POLYCARBONATE FOIL AFTER FAST NEUTRON EXPOSURE. Tuyn, J. W. N.; Broerse, J. J. (Reactor Centrum Nederland, Petten, Netherlands). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The registration of relatively light charged particles like carbon and oxygen recoils, and α-particles in Makrofol E polycarbonate foil can be used for fast neutron dosimetry. Therefore, an analysis was made of the etch pit size distribution in Makrofol foils after exposure to mono-energetic neutrons produced by the D(d,n)^{3}He and T(d,n)^{4}He reactions. The dependence of the etch pit size distribution on the angle of neutron incidence and the neutron energy was studied. An empirical relation is given for the maximum diameter of the etch pits as a function of etching time and neutron energy which fits the experimental data within a wide energy range. The ratio of optical density and darkfield light intensity for exposed and etched foils was found to be strongly dependent on the etch pit size distribution. (auth)

18283 (CONF-700705-(Vol.2), pp 543-551) COLLECTION OF THE DAUGHTERS OF RADON ON A FILTER. Discrimination and Counting of the Alpha Particles Emitted by Means of the Tracks Registered in Cellulose Nitrate. Anno, J. (Centre de Physique Atomique et Nucleaire, Toulouse); Blanc, D.; Teyssier, J. L. 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

It is known that air contains three natural radioactive gases: radon, thoron, and actinon. The first is the most abundant. In order to detect it, use is made of the fact that it has two solid daughters that decay by emitting an alpha particle: radium A and radium C′. The radium A and radium C′ are collected on a filter and the number of tracks left in a solid visual detector by the alpha particles they emit is calculated. From this is deduced the activity of the radon at the moment the operation of filtration is stopped. The detector chosen is made of cellulose nitrate. It has the advantage of registering the number of tracks from alpha particles with energy less than 4 MeV. On the other hand, it is not very sensitive to light and humidity, and it is strong and not very expensive. (tr-auth)

18284 (CONF-700705-(Vol.2), pp 585-590) HEAVY ION MONITORING OF BIOLOGICAL TARGETS BY MEANS OF NUCLEAR TRACK DETECTORS. Benton, E. V. (Univ. of San Francisco); Curtis, S. B.; Lyman, J. T.; Tobias, C. A.; Yang, T. C. H. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Plastic nuclear track detectors are being utilized in heavy ion irradiation monitoring of biological targets. Recent experiments performed at the Hilac accelerator indicate that accurate extrapolation of particle trajectories from the detector into the target are possible. This allows the determination of the number and the location of particle hits in the target. Other important features of this method are discussed. (auth)

18285 (CONF-700705-(Vol.2), pp 671-674) AUDIOVISUAL DISCRIMINATION FOR TRACK MEASUREMENTS IN EMULSIONS. Medveczky, L. (Inst. of Nuclear Research, Debrecen, Hungary). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A semiautomatic digital microscope for readout of nuclear emulsion particle tracks is briefly described. (WHK)

18286 (CONF-700705-(Vol.2), pp 675-679) Z-COORDINATE MEASUREMENTS IN PLASTIC-DETECTORS. Fukui, K. (Cambridge Research Labs., Bedford, MA); Beaujean, R.; Enge, W. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A study to determine the reliability of the reading of the z-coordinate of the tip of a track cone in dielectric track detectors is described. Direct measurements of the coordinate of the tips from the side view of the track were made. (WHK)

18287 (CONF-700705-(Vol.2), pp 681-710) SEMI-AUTOMATIC SCANNING OF TRACKS IN PLASTICS. Khan, H. A. (Univ. of Birmingham, Eng.). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Two attempted automatic scanning methods for particle tracks in dielectric track detectors for very high and very low fluences of fission fragments and alpha particles are described. One method is based on the scattering of visible light by the etched tracks; the other method is based on the dyeing of tracks by red ink. Results are presented and discussed. (WHK)

18288 (CONF-700705-(Vol.2), pp 711-718) INVESTIGATIONS ON ALPHA-RAY PATTERNS IN DIELECTRIC FOILS. Somogyi, G.; Srivastava, D. S. (Inst. of Nuclear Research, Debrecen, Hungary). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Americium-241 alpha particles were registered in cellulose nitrate, cellulose acetate, and polycarbonate foils. The track etching conditions and the resulting optical density characteristics are presented. (WHK)

18289 (CONF-700705-(Vol.2), pp 719-722) EFFECT OF IRRADIATION IN VACUUM ON THE OPTICAL DENSITY CURVES FOR α-PARTICLES IN PLASTICS. Somogyi, G.; Srivastava, D. S. (Inst. of Nuclear Research, Debrecen, Hungary). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

To show the effect of environmental conditions on the track registration features of plastic track detectors, the variation of optical density in various plastic track detectors when they were irradiated in vacuum were studied. (WHK)

18290 (CONF-700705-(Vol.2), pp 723-728) SOLID VISUAL DETECTORS: AUTOMATIC COUNTING OF TRACKS AND LAW OF LOSSES BY OVERLAPPING. Rueegger, B.; Richmond, R.; Zuercher, W. (Institut Federal de Recherches en Matiere de Reacteurs, Wuerenlingen, Switzerland). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

It has been shown that the amount of fission can be measured by means of plastic track detectors, the density of tracks being obtained with a Quantimet 720. The following have been established: the reproducibility of measurements to be better than 1%, a law of losses by overlapping, and the measurement of the distribution of the amount of fission of ^{235}U in a fuel cluster agrees very well with the results obtained by gamma counting. The method can thus be used for the general study of fission, relative and absolute, in the lattices of nuclear reactors. (tr-auth)

18291 (CONF-700705-(Vol.2), pp 729-735) ON-LINE SEMI-AUTOMATIC MEASUREMENTS OF MULTIPLE FRAGMENT REACTIONS OBTAINED AT INTERMEDIATE ENERGIES ON THE LIGHT NUCLEI OF THE EMULSION. Jacquot, C.; Volmer, P.; Jung, M.; Cuer, P. (Centre de Recherches Nucleaires, Strasbourg). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Nuclear reactions detected by ionographic matter are measured with a semi-automatic system that digitizes the experimental matter on three orthogonal coordinates. A CDC 1700 on-line computer tests continuously the precision and dispersion of measurements and controls and corrects the operator in the logical sequences. The computer reconstructs the geometry and identifies completely the break-up events through the energy-momentum conservation law as a process similar to that of the bubble chamber. (auth)

18292 (CONF-700705-(Vol.2), pp 737-744) HIGH SPATIAL RESOLUTION FISSION DETECTOR. Besant, C. B. (Imperial Coll. of Science and Tech., London). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A technique for fission rate measurements in zero power fast reactors based on electron microscope measurements of unetched particle tracks in dielectric track detectors is described. It is possible to detect track densities of up to 10^8 tracks/mm^2 without serious track overlap interfering with counting. (WHK)

18293 (CONF-700705-(Vol.2), pp 753-757) IONIZING PARTICLE SENSITIVITY OF PHOTOGRAPHIC EMULSIONS WITH LAMINATED MICROCRYSTALS. Kartuzhanskii, A. L.; Martysh, G. G.; Shur, L. I.; Ginzburg, K. M.; Grinshpun, S. G. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The results of a study on the photographic characteristics of emulsions with microcrystals of laminated structure, i.e., with

the central part formed by one silver halide and the surface part formed by another, are briefly discussed. The photographic action of β particles on [(AgCl)AgBr] emulsions were studied. (WHK)

18294 (CONF-700705-(Vol.2), pp 759-764) PARAMAGNETIC PROPERTIES OF NUCLEAR PHOTOGRAPHIC EMULSION. Veprik, J. M.; Trukhin, M. I.; Shelekhin, J. L. (Ioffe Inst. of Physics and Tech., Leningrad). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The paramagnetic properties of the real microcrystals of AgBr(I) nuclear emulsions and the application of the discovered paramagnetism for the investigation of the nature of the sensitivity of the emulsion sensitized by different structure ethanolamines were studied. (WHK)

18295 (CONF-700705-(Vol.2), pp 765-774) VISUAL METHODS FOR MEASURING SOME FEATURES OF BEAM PARTICLE TRACKS IN NUCLEAR EMULSIONS. Baranov, V. I. (Inst. for High Energy Physics, Serpukhov, USSR). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

An original method for fast estimation of angular and other features of beam particle tracks by nuclear emulsions without using a microscope is described. This method is based on the irregularity measurements of the visible raster in the emulsion layer. The investigated charged particle tracks are used as raster elements. (auth)

18296 (CONF-700705-(Vol.2), pp 775-779) PEO: EFFECT IN THE DEVELOPERS FOR NUCLEAR PHOTOGRAPHIC MATERIALS. Kocherov, N. P.; Novikova, N. R. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Polyethylene-oxides (PEO) are used for improving the light-sensitivity of photographic materials. The PEO is introduced into the emulsion or into developing solutions and increases the electron sensitivity of extra-fine-grain emulsions. The effect of PEO in different developers used for processing nuclear photographic layers is studied. (WHK)

18297 (CONF-700705-(Vol.2), pp 781-787) EXTRA-FINE-GRAIN NUCLEAR EMULSIONS AND THEIR PHOTOGRAPHIC PROCESSING (REVIEW). Perfilov, N. A.; Novikova, N. R.; Zakharov, V. I.; Kocherov, N. P. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The processing and development of extra-fine-grain nuclear emulsions is discussed. The characteristics of 10 types of such emulsions are tabulated. (WHK)

18298 (CONF-700705-(Vol.2), pp 789-793) SENSITIZING EFFECT OF POLYETHYLENE OXIDE IN EXTRA-FINE-GRAIN NUCLEAR EMULSIONS. Novikova, N. R.; Perfilov, N. A.; Zakharov, V. I. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The sensitization of extra-fine-grain nuclear emulsions with polyethylene oxide, used either in the liquid emulsion prior to coating or added to the developer, is studied. (WHK)

18299 (CONF-700705-(Vol.2), pp 795-807) CALCULATION OF THE IONISATION PARAMETER G IN NUCLEAR EMULSIONS OF VARIOUS SENSITIVITIES BY MEANS OF A COMPUTER CODE. Ortega, M.; Fernandez, F.; Kaiser, R.; Medina, J.; Dura, A.; Gandia, V. (Univ. Autonoma, Barcelona). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A computer code for calculating the g-parameter in nuclear emulsions is discussed. Three different ways to compute the desired value have been devised and the best one in each case is chosen. The method is suitable for particles of arbitrary charge and relativistic velocities in nuclear emulsions of various sensitivities. (WHK)

18300 (CONF-700705-(Vol.2), pp 817-824) CALCULATION OF THE SPECIFIC ENERGY LOSS PER UNIT LENGTH IN THE CASE OF MINIMUM IONIZATION FOR IONS OF $Z \leq 10$ AND FOR DIFFERENT DILUTE NUCLEAR EMULSIONS. Dura, A.; Fernandez, F.; Medina, J.; Gandia, V. (Univ. Autonoma, Barcelona). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The range–energy curves and specific energy loss for $Z \leq 10$ in various nuclear emulsions are calculated and presented. (WHK)

18301 (CONF-700705-(Vol.2), pp 825-836) SOME REGISTERING CHARACTERISTICS OF PLASTIC PARTICLE DETECTORS IN VACUUM AND IN GASEOUS MEDIA. Girshin, A. B.; Kartuzhanskii, A. L.; Martysh, G. G.; Privalova, V. E.; Shur, L. I. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A study of the characteristics of plastic track detectors for α-particle and multicharged heavy-ion detection in vacuum and in gaseous media is described. The experiments were conducted at the A. F. Ioffe Phys.–Techn. Institute cyclotron. (WHK)

18302 (CONF-730824-1) MODERN TECHNIQUES AND APPLICATIONS IN CHERENKOV COUNTING. Ross, H. H.; Rasmussen, G. T. (Oak Ridge National Lab., Tenn.). 1972. 19p. Dep. NTIS $3.00.

From international symposium on liquid scintillation counting; Sydney, Australia (20 Aug 1973).

Cherenkov counting, a relatively unknown technique in the laboratory five years ago, has recently become the method of choice for counting many beta-emitting nuclides on a routine basis. The interest in this method is due, in part, to the ease in employing conventional liquid scintillation counting equipment without modification. Unfortunately, this similarity in measurement routine and equipment has led some investigators to believe that procedures developed for organic scintillation counting are directly applicable to Cherenkov systems. Unfortunately, this is far from true. Therefore, the following presentation has a three-fold purpose. First, a general review of the Cherenkov physical process is presented. Particular attention is given to the mechanism of Cherenkov radiation production, energy input-output characteristics, and spacial phenomena. The unusual properties of Cherenkov systems and how they may be used to advantage in practical counting situations is stressed. Also, an attempt is made to delineate important points of departure between organic liquid scintillation and Cherenkov methods. A second objective is to describe special measurement techniques that have been applied to Cherenkov counting problems. Among those discussed are the use of waveshifters, solvent selection, quenching, and standardization procedures. Finally, the results of an original study concerning a computer simulation of the Cherenkov process developed to establish optimal counting conditions for dual isotope experiments are presented. This technique is particularly interesting because it appears to be generally applicable to both Cherenkov and conventional liquid scintillation counting procedures. Use of a simple computer program allows one to quickly set-up his instrument for optimum isotope separation and also to evaluate the probable limits of error in the measurement. (auth)

18303 (FRNC-TH-363) STUDY AND DEVELOPMENT OF A DIGITAL SYSTEM FOR THE COMMAND OF AN ASSEMBLY FOR MEASURING ANGULAR DISTRIBUTIONS AND CORRELATIONS. Pfleger, J. C. (Strasbourg Univ. (France)). 1972. 127p. (In French). Dep. NTIS (U. S. Sales Only) $8.50.

Thesis.

An assembly for the digital command of the angular position of two angular correlation detectors is studied. Uniform digital binary codes were used. The determination of the logic circuitry of the various processing blocks was affected using basic Boolean algebra rules and optimizing methods for the logic equations, particular attention being given to the Karnaugh method. The assembly presented can be divided into two parts: the angular correlation measurement table for which a model has been developed; and the control assembly provided with the electronic part which can be connected to an existing angular correlation table by making certain modifications. The various position sensors and servomechanism elements are described. The command assembly enable a time gain to be obtained during handling and a reduction in the exposure to nuclear radiations to be achieved as a result of remote action. (FR)

18304 (JPRS-59523, pp 9-39) PROPERTIES OF MATERIALS USED IN SEMICONDUCTOR RADIATION DETECTORS. Giriat, W. 16 Jul 1973. Translated from Postepy Fiz., 23: No. 4, 329-350(1972).

Crystal growth, preparation, and properties of cadmium telluride, mixed crystals of mercury chalcogenides, and mixed crystals of lead compounds for detection of nuclear radiation and infrared radiation are discussed. Also, materials for infrared optics are discussed. (WHK)

18305 (JPRS-59634, pp 1-28) SEMICONDUCTOR DETECTORS OF NUCLEAR RADIATION. Chwaszczewska, J. 26 Jul 1973. Translated from Postepy Fiz.; 23: No. 4, 351-368(1972).

The design, fabrication, operation, and performance of semiconductor detectors are reviewed. (29 references.) (WHK)

18306 (MLM-1971) DEVELOPMENT AND USE OF AN ENERGY INSENSITIVE NEUTRON COUNTER. Neff, R. A. (Mound Lab., Miamisburg, Ohio). 31 Jul 1973. Contract AT-33-1-GEN-53. 11p. Dep. NTIS $4.00.

A neutron counter with both the neutron detector (a BF_3 tube) and the neutron source located within the moderating material has been developed for routine neutron emission measurements

on small (<2.5-cm-diameter) neutron sources. This counter has an efficiency greater than 100 times that of a Precision Long Counter while still maintaining a relatively energy-independent response. (auth)

18307 (N-73-18826) DEVELOPMENT AND INVESTIGATION OF PARTICLE DETECTORS IN SUPPORT OF OUTER PLANET DEFINITION STUDIES. Final Report, 1 July 1971–30 September 1972. Vogt, R. E. (California Inst. of Tech., Pasadena). 30 Sep 1972. 24p. (NASA-CR-130917). NTIS.

Research is reported in support of the definition phase of the Outer Planets Missions. The definitions studies are discussed along with the investigations of the triple-grooved solid-state detectors. (STAR)

18308 MONITOR OF THE CONCENTRATION OF RADIOACTIVE IODINE IN A STREAM OF GAS. Lattin, K. R. (to United States Atomic Energy Commission). U. S. Patent 3,731,100. 1 May 1973. Filed date 7 Apr 1971. 4p.

The concentration of a radioactive substance in the effluent from a nuclear reactor is measured by counting total radiation in the effluent, filtering out the particular radioactive substance, counting total radiation in the filtered effluent, and combining the results. This method is particularly sensitive to rapid changes in the concentration, and is especially adapted to the monitoring of amounts of radioactive iodine. (Official Gazette)

18309 METHODS FOR CALCULATING THE DEADTIME OF ANGER CAMERA SYSTEMS. Adams, R.; Zimmerman, D. (Loma Linda Univ., CA). J. Nucl. Med.; 14: No. 7, 496-498(Jul 1973).

Three methods for calculating the deadtime in scintillation cameras by the two-source method are presented. Their accuracy is compared with that of seven methods that have been described. (auth)

18310 IONIZATION CHAMBER WITH A LARGE SURFACE. Taube, H. (to Veb RFT Messelektrnik Dresden). German Patent 1,589,038. 26 Mar 1970. Filed date 12 Nov 1966. (In German).

An ionization chamber particularly suited for an automatic x-ray apparatus that is characterized by a collector consisting of two thin synthetic plates the surfaces of which are superposed and connected to each other placed between two external electrodes is described. (TSS)

18311 FABRICATION OF A SEMICONDUCTOR RADIATION DETECTOR. Ruge, I.; Sigmund, H. German Patent 1,614,363. 27 May 1970. Filed date 18 Apr 1967. (In German).

A process is described for the fabrication of a radiation detector provided with a p–n semiconductor layer which, during the time that it is in service and in a nonconducting state, has only one multiplication region of very reduced range. (TFD)

18312 NEUTRON-SENSITIVE IONIZATION CHAMBER. Mayer, W. (to Licentia Patent Verwaltungs GmbH). German Patent 1,904,407. 10 Sep 1970. Filed date 30 Jan 1969. (In German).

A gas-filled ionization chamber, sensitive to neutrons in which an exterior cylindrical electrode surrounds an interior cylindrical electrode at a fixed distance is described. The inside electrode is hollow. Openings for equalization are provided permitting communication between the interior of the cylinder and the active gas. (TSS)

18313 EFFECT OF GAMMA IRRADIATION ON CELLULOID FILM AND RELATED INFLUENCE ON THE REGISTRATION OF ALPHA TRACKS. Takemi, H.; Kinaga, Y.; Shinagawa, M. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 10: No. 4, 214-218(Apr 1973).

Celluloid film, used for α-track detection was irradiated up to 3.5×10^7 rad by ^{60}Co γ-rays. The radiation damage was examined by weighing a piece of the film before and after etching with sodium hydroxide solution under various conditions. Six molar sodium hydroxide solution at 50°C was found to be the most suitable etching solution for this irradiated celluloid film. On measuring the optical density, it was seen that the absorption curve for UV light shifted to the longer wavelength side accompanying an increase of absorption dose of γ-ray energy on the film. Both the gravimetric and the optical methods of determining radiation damage indicated its dependence on the γ-ray absorption dose. The sensitivity of α-track registration was also estimated by examining the appearance of α-tracks under the optical microscope according to etching time. The critical energy of the celluloid film for the registration of α-tracks decreased with the absorption dose of γ-rays. (auth)

18314 UZLY RADIOMETRICHESKOI APPARATURY NA INTEGRAL'NYKH AKHWMKH. (Integrated Circuit Subassemblies for Radiometric Apparatus). Gorn, L. S.; Khazanov, B. I. Moscow; Atomizdat (1973). 228p.

The construction of the principal subassemblies for radiation detection instruments using integral circuits is considered. The present-day microelectronic basis for the devices and the construction of signal booster circuits for radiation detection instruments and circuits of amplitude devices, time selectors, form selectors, power supply, etc. are examined. Special attention is given to the construction of different devices for pulse counting and measurement of average frequencies. The worth of the functional-subassembly method of construction of apparatus in integrated circuits is evaluated. (tr-auth)

18315 DEVELOPMENT OF A MONITOR FOR THE CONTINUOUS MEASUREMENT OF AIRBORNE RADIOACTIVE IODINE. Wilhelm, J. G. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 18: No. 6, 297-299(1973). (In German).

The detection of ^{131}I, which is the most significant from the point of view of safety, in atmospheric concentrations of 2×10^{-9} Ci/m^3 which is required by the German 1st Radiation Protection Regulation demands a special measurement technique. A monitor has been developed for the continuous measurement of the ^{131}I content of air in which the ^{131}I is accumulated in a special filter cartridge. The I activity is measured continuously during the accumulation process by means of a detector and displayed on a ratemeter. Elemental iodine and methyl iodide can be measured with the same detection sensitivity even in air of extremely high relative humidity. (GE)

18316 MOVABLE AND ADJUSTABLE HEIGHT SUPPORT. Tonnelier, C.; Zerbib, J. C. (to Commissariat a l'Energie Atomique). French Patent 2,135,831. 30 Apr 1971. 5p. (In French).

A movable and adjustable height support is presented. It is intended to support radiation detectors used in irradiation experiments and consists of a base plate mounted on small wheels provided with brakes. A hollow vertical cylinder is attached to the base plate. A piston slides up and down inside this cylinder. The cylinder is open at its upper end and closed at its lower end with a plug. The upper part of the cylinder is provided with a ring which can be tightened with a handle and serves to fix the piston in the cylinder. A horizontal table is attached to the upper part of the piston. (FR)

18317 THIN POLYPROPYLENE WINDOW PROPORTIONAL COUNTERS FOR THE OBSERVATION OF SOFT COSMIC X-RAYS. Kato, T.; Kohno, T.; Nagase, F.; Nishimura, K.; Tanaka, Y. (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 11: No. 9, 1351-1356 (Sep 1972).

Thin polypropylene window proportional counters are being developed for rocket observations of cosmic soft x rays. Film thicknesses down to half a micron have been obtained, and practically all wavelengths shorter than 100Å have become observable. This technique is also applicable to the detection of electrons above a few keV whose existence at rocket altitudes has been recently discovered. The preparation of thin polypropylene film, its application to proportional counter and the associated gas control systems are described. An electrostatic shutter which discriminates between soft x rays and low-energy electrons is tested, and its function in the ambient plasma is also discussed. (auth)

18318 ELECTRONIC SAFETY TEST REPLACES RADIOACTIVE TEST SOURCE. Guerin, D. W. (S. Davall and Sons, Ltd., Greenford, Eng.). Aircraft Eng.; 45: 10(Apr 1973).

An ionizing radiation and neutron detection system designed for use on Concorde aircraft is described. The system comprises silicon microcircuits, a stable-frequency oscillator, signal processing circuits, and an indicating unit which are activated by ionization pulses and neutron pulses from detectors. (IAA)

18319 METHOD AND APPARATUS FOR THE CONTINUOUS MEASUREMENT OF THE TRITIUM CONTENT OF WATER. Kiefer, H.; Maushart, R. (to Gesellschaft fuer Kernforschung mbH). German Patent 1,498,832. 23 Oct 1963. Filed date 30 Jan 1960. (In German).

A method for continuous measurement of tritium content in water is described. It is characterized by the fact that the water containing tritium is at least in part mixed with a counting gas passing into the ionization detector and in which a deposition of moisture is impossible and the tritium beta particles are measured one by one. (TSS)

18320 RESOLVING TIME MEASUREMENTS OF GM AND GAS-FLOW COUNTERS USING A TIME-TO-AMPLITUDE CONVERTER. Nakamoto, S. (Chubu Inst. of Tech., Japan). Jap. J. Appl. Phys.; 11: No. 11, 1686-1692(Nov 1972).

A slow time-to-amplitude converter was fabricated for the time

interval measurements of self-quenching type GM and gas-flow counters. With this converter, the resolving times of counters were analyzed. The resolving time has the peak value at the beginning of the GM-threshold voltage and decreases at the higher supplied voltage. The approximate position of the ion sheath of the normal discharge at which the field strength of a counter recovers to the GM-threshold is also determined by comparing the resolving time with the calculated velocity of the ion sheath. The resolving time is proportional to the pulse amplitude at low supplied voltages and is nearly constant at higher voltages. These phenomena can be explained by the recovery curves of the field strength near the center wire. Another application of the converter is also suggested. (auth)

18321 GAMMA-RAY EFFICIENCY VALUES FOR NaI-DETECTORS. Intercomparison of Different Source-to-Detector Geometries. Holmberg, P.; Nikurautio, A. (Univ. of Oulu, Finland). pp 73-75 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The influence of detector volume on the efficiency values is presented for 1″ × 1″ to 6″ × 6″ NaI-detectors. Efficiency values for point source and extended source geometries (solid detectors and well-type detectors) are intercompared. (auth)

18322 SYSTEM FOR OBSERVING A RADIOACTIVE INDICATION SUBSTANCE. Ruotsalainen, P.; Hietakari, H. (Tampere Central Hospital, Finland). pp 197-201 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

A scintillation detector system is described for dynamic function studies in man such as lung function, brain blood circulation, and renography. (WHK)

18323 COUNTER FOR RADIATION MONITORING. Brunson, G. S.; Curran, R. N.; Just, F. H. (to United States Atomic Energy Commission). U. S. Patent 3,732,422. 8 May 1973. Filed date 23 May 1972. 6p.

A radiation counter repeatedly takes periodic samples by counting radiation pulses which are received during a predetermined period. The predetermined period is measured by a timing circuit. An amplitude measuring circuit measures the amplitude of the incoming radiation pulses and acts to disable the timing circuit whenever a radiation pulse above a particular amplitude is received. By disabling the timing circuit, dead time, during which the counting circuit will not detect radiation pulses, is not counted as part of the predetermined counting period. (Official Gazette)

18324 RADIATION SURVEY VEHICLE FOR THE NAL MAIN RING. Shafer, R. E.; Jovanovic, D. D. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 499-501(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A battery-powered golf cart was instrumented for making routine radioactivity surveys of the NAL Main Accelerator. The purpose of the surveys is to provide complete and reproducible plots of induced radioactivity for radiation safety, extrapolation to higher intensity operation, and accelerator diagnostics. The design of the vehicle is discussed, and some results of surveys are presented. (auth)

18325 NEW GAMMA DETECTORS OF MERCURY IODIDE AND OTHER HEAVY METAL COMPOUNDS. Willig, W. R. (Siemens AG, Erlangen, Ger.). Siemens Forsch.-Entwicklungsber.; 2: No. 3, 157-160(1973).

One of the advantages of Ge and Si semiconductor detectors is the low radiation absorption. New energy resolving gamma detectors are investigated which consist of semiconductor compounds with a very high atomic number and operate on the same principle as gas ionization chambers. A brief theoretical consideration is followed by the preparation of PbO, PbI_2, and HgI_2 monocrystals. First spectral measurements are presented. From these HgI_2 seems to be particularly suitable as a gamma detector due to its high radiation absorption which may permit the miniaturization of detectors and thus possibly open up new applications. (GE)

18326 DETECTOR OF CORPUSCULAR AND IONIZING RADIATION. Dieck, L. (to Kernforschungsanlage Juelich GmbH). German Patent 1,614,028. 27 May 1970. Filed date 21 Dec 1967. (In German).

A fine counting wire is held in a container with thin walls at high-voltage filled with a gas and commuted in a circuit of commutation in such a way that the quotient, on the arrival (at the two extremities of the counting wire) of an event for registration, indicates the location of the discharge on the counting wire and the total of the signals. (TSS)

18327 INFLUENCE OF PROPERTIES OF A SCINTILLATOR ON COUNTING CHARACTERISTIC PLATEAU. Kibal'chich, G. A.; Tsirlin, Yu. A. Monokrist. Tekh.; No. 5, 178-186(1971). (In Russian).

The influence of the type of scintillator (S) used, the degree of its phosphorescence, conversion effectiveness, light collection, dimensions and shape of the S on the counting plateau (P) was studied. It is shown that the shape of the S has a significant influence on the P of the counting characteristic; this is determined by the form of the differential distribution and ratio of signal and noise amplitudes. Organic S has no phosphorescence, while single crystals of sodium iodide have varying degrees of phosphorescence. Increasing the conversion effectiveness improves P, while increasing the light collection factor may have varying influence on the P. An increase in the dimensions of sodium iodide single crystals improves P. Single crystals with low ratio of height to diameter have good P, while when this ratio is increased to 4 to 7, P is somewhat worsened. However, at the same time the sensitivity increases and it becomes possible to determine the direction of propagation of γ-radiation (γ direction finding). In this case, the counting rate recorded depends on the angle formed by the axis of the S and the direction of propagation of the γ radiation. (JPRS)

Radiation Dosimeters

Refer also to abstracts 19008 and 20152.

18328 (AD-757191) MODIFICATIONS OF FRICKE DOSIMETER FOR MEASURING HIGH RADIATION DOSES. Final Report, 1 June 1971–15 May 1972. Hardy, K. A.; Witschy, J. K. (School of Aerospace Medicine, Brooks AFB, Tex.). Dec 1972. 23p. (SAM-TR-72-22). NTIS.

The effects of adding excess cupric sulfate to the standard Fricke dosimeter system were observed in measuring large radiation doses. Various concentrations of ferrous ammonium sulfate in this system were investigated for deviations from linear response. The effects of various concentrations of cupric sulfate were also observed. A solution containing 0.003 M ferrous ammonium sulfate, 0.01 M cupric sulfate, and 0.01 N sulfuric acid gave a linear response to doses in excess of 2.0 Mrad and was chosen for further study. The G (Fe (3+))Cu (2+) values for this solution were determined both for ^{60}Co gamma radiation and for 6 MeV electrons produced by a clinical linear accelerator, and were found in both cases to be 0.66 ions/100 eV absorbed. Self-oxidation of the final dosimeter solution and the stability of induced signals were also observed. (auth)

18329 (CONF-700705-(Vol.2), pp 527-531) USE OF MAKROFOL POLYCARBONATE FOILS FOR THE MEASUREMENT OF THE FAST NEUTRON DOSE DISTRIBUTION INSIDE A HUMAN PHANTOM. Tuyn, J. W. N.; Broerse, J. J. (Reactor Centrum Nederland, Petten, Netherlands). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The application of Makrofol foils for absorbed neutron dose measurements was tested by exposing foils inside a human phantom and comparing the experimental data with the results of tissue equivalent ionization chamber measurements. The optical density distribution of the exposed foils was found to be in agreement with the ionization chamber results. The ratio of optical density and darkfield light intensity is a function of the depth in the phantom. The absorbed dose distribution can also be derived from etch pit counting, but in this case the best fit is obtained when only the number of etch pits with a diameter above a certain threshold is counted. (auth)

18330 (CONF-700705-(Vol.2), pp 591-610) DOSIMETRY OF SPACE RADIATIONS. Kaiser, R. (Centre de Recherches Nucleaires, Strasbourg). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The requirements and factors to be considered in the selection of dosimeters for use in space are discussed. Characteristics of specific dosimeters are discussed including thermoluminescent dosimeters (lithium fluoride, calcium fluoride, and lithium borate), nuclear emulsions, and dielectric track detectors. Experimental results are given for the Mercury, Gemini and Apollo missions as well as several Soviet missions. Soviet and US dosimetric techniques are compared. Results of measurements of radiation doses in various US and USSR space missions are tabulated. The

heavy ion flux measured on Apollo VII and VIII space flights are given. (WHK)

18331 (GSF-S-124) EXPERIENCES WITH THE LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETRY SYSTEM AND RECOMMENDATIONS FOR ITS PRACTICAL APPLICATION. Regulla, D. F.; Balasubrahmanyam, V. (Gesellschaft fuer Strahlen- und Umweltforschung M.B.H., Neuherberg Bei Munich (West Germany). Institut fuer Strahlenschutz). Feb 1971. 55p. INIS.

Typical error sources in LiF-thermoluminescence dosimetry are discussed. Several types of LiF-detectors have been tested (LiF-powder, imbedded in plastics and sintered into solids) and their reproducibility and accuracy in a certain dose range has been compared. Moreover, the influences of environmental factors (temperature, light) have been studied. Finally, as a result of the investigations, recommendations are given for an optimum LiF-dosimetry and the corresponding methods of evaluation and regeneration. (INIS)

18332 (KFKI-73-18) IONIZATION CHAMBER SYSTEM FOR HIGH DOSE-RATE-MEASUREMENTS IN MIXED n-GAMMA FIELD. Zarand, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Apr 1973. 17p. Dep. NTIS (U. S. Sales Only) $3.00.

Different parallel plate ionization chambers have been constructed for high-intensity mixed neutron-gamma dose rate measurements. The neutron-chambers are made of polyethylene and tissue equivalent conducting plastic, respectively with ethylene as a filling gas. The gamma chambers are CO_2-filled graphite or Ar-filled Al chamber. Some problems of chamber design, collection efficiency and that of calibration are discussed and measurements in the biological irradiation facility operated in Central Research Institute for Physics are presented. (auth)

18333 (KAPL-P-3965) MANUAL OR AUTOMATED AND COMPUTERIZED TLD SYSTEM FOR PERSONNEL AND ENVIRONMENTAL RADIATION EXPOSURE MONITORING. Zendle, R.; Schunicht, B. F.; Champagne, R. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). 1973. Contract W-31-109-eng-52. 41p. (CONF-730603-10). Dep. NTIS $4.25.

From eighteenth Health Physics Society meeting; Miami Beach, Florida, USA (17 Jun 1973).

The TLD system at Knolls Atomic Power Laboratory is described. The TLD film badges and automatic readout system are described, and results of performance tests are given. (WHK)

18334 (UCRL-50007-72-3, pp 1-3) DEVELOPMENTS IN LIGHT PARTICLE TRACK REGISTRATION FOR PERSONNEL NEUTRON DOSIMETRY. Griffith, R. V. 29 Mar 1973.

In hazards control progress report No. 44.

Neutron dosimeters based on fission track registration contribute to the radiation dose of the wearer. Research work on development of neutron dosimeters based on light particle track registration using non-radioactive materials is reported. The systems investigated included $^{6}Li(n,\alpha)H^{3}$ and $^{14}N(n,p)^{14}C$ with cellulose nitrate used as the registrant. (TFD)

18335 (UCRL-74855) NEUTRON DOSIMETRY STUDIES AT LLL. Griffith, R. V. (California Univ., Livermore. Lawrence Livermore Lab.). 9 Jul 1973. 7p. (CONF-730647-1). Dep. NTIS $3.00.

From USAEC personnel neutron dosimetry workshop meeting; Miami Beach, Florida, USA (14 Jun 1973).

The major emphasis in neutron dosimetry development over recent months has been devoted to calibration facility improvement. Work on source upgrading inventory; fabricating moderators for use with new sources; developing a capability for low-level neutron spectra measurements; and dosimeter development is summarized. (WHK)

18336 DOSIMETER FOR THE DETERMINATION OF RADIATION INTENSITY. Girle, H. (to Graetz KG). German Patent 1,564,014. 8 Jan 1970. Filed date 15 Jul 1966. (In German).

An integrating-type ionization chamber for dosimetry is described. (TSS)

18337 ACTIVATION DETECTOR FOR NEUTRON DOSIMETRY. Tschirf, E. (to Total Foerstner and Co.). German Patent 1,614,745. 10 Dec 1970. Filed date 4 Jan 1967. (In German).

An activation detector for neutron dosimetry consisting of two constituent elements that react differently to thermal and fast neutrons is described. The two elements are oriented in the same direction. (TSS)

18338 POCKET WARNING DEVICE FOR RADIOACTIVITY. Zwiebel, H. (to Bandelin Electronic KG). German Patent 1,589,515. 26 Feb 1970. Filed date 15 Apr 1967. (In German).

A pocket dosimeter is described that consists of a G-M counter that emits an acoustic signal when a predetermined dose is exceeded. It also has an indicator that shows when the maximum permissible dose is exceeded. (TSS)

18339 READOUT FOR PHOSPHATE GLASS DOSIMETER. Kimmel, H. German Patent 1,614,002. 6 May 1970. Filed date 6 Mar 1967. (In German).

A device is described for reading the radiation from a phosphate glass dosimeter that communicates to the condenser a continuous voltage corresponding to the radiation from the dosimeter, characterized by a discriminating regulating device that opens it when the continuous voltage exceeds a threshold value and closes it when the continuous voltage drops below this threshold value by means of a circuit supplying the readout device and an indicator counting the impulses that the discriminator allows to pass. (TSS)

18340 RADIATION DOSIMETER. Epple, R. (to Telefunke Patentverwertung GmbH). German Patent 1,614,764. 10 Dec 1970. Filed date 9 Feb 1967. (In German).

A dosimeter consisting of a semiconductor diode sensitive to radiation and serving as a radiation indicator is described. To compensate for the temperature sensitivity of this diode a second semiconductor diode that is sensitive to radiation is provided. (TSS)

18341 CHEMICAL DOSIMETRY. Pychlau, P. (Physikalisch Technische Werkstaetten, Freiburg i. B.). (1972). vp. (In German).

From joint meeting of the German Society for Biophysics and German Society for Medical Physics; Erlangen, Germany (4 Oct 1972).

A method of chemical dosimetry is presented which is based on the work of Fricke and which has been developed by Frankenberg. The practical applicability is given in detail using prepared solutions and a calorimeter as a measurement device. This method is especially suitable for therapy praxis in order to measure the energy dose at single points of a phantom, supplementing ionization chamber measurements. (GE)

18342 ALIGNMENT OF DOSIMETER CALIBRATIONS WITH PRIMARY REFERENCE BEAM STANDARDS. Le Roy, G.; Leuzinger, S. (Industries Electriques, Fontenay-aux-Roses, France). Rev. Gen. Elec.; 82: No. 3, 153-161(Mar 1973). (In French).

The calibration centers approved by the National Bureau of Metrology are obliged to align their measurements on x and γ radiations with those made with reference beams at the Primary Laboratory for the Metrology of Ionizing Radiations. Three radioactive beams are used as national reference standards. The methods adopted at the Laboratoire Central des Industries Electriques to align the calibrations made with x radiation and the primary beam from an americium source are described. The results obtained are given, e.g., choice of measurement standard, and uncertainties. An appendix is presented in which the results of a study of the response curves for monochromatic radiation emitted in fluorescence and the response of several different dosimeters as a function of the energy of the radiation are given. (FR)

18343 DOSIMETER FOR PENETRATING IONIZING RADIATION WHATEVER THE COMPOSITION OR SPECTRUM. Zielczynski, M.; Zarnowiecki, K. (to Institut Badan Jadrowych). German Patent 1,911,229. 27 Aug 1970. Filed Date 5 Mar 1968. (In German).

A dosimeter for penetrating ionizing radiation of any composition or spectrum whatever, consisting of a detector, a power supply, and a registration apparatus is described. The detector is a differential chamber one part of which operates under conditions of saturation, whereas the other insures recombination of the ions in the pile. The registering device is a reaction electrometer of which one terminal at the entrance is in direct contact with a measuring electrode of the chamber, whereas the other is short-circuited with the unit and the protection ring of the chamber. (TSS)

18344 BENZOIC ACID AND POLYACRYLAMIDE AS RADIATION DOSIMETERS. Rytilae, A. (Univ. Central Hospital, Helsinki). pp 80-82 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

Benzoic acid is quantitatively hydroxylated by irradiation in aqueous solution. Analysis with fluorometry is used on the dosimetric solution. The reagents used for the benzoic acid dosimeter

were as follows: benzoic acid, sodium hydroxide, salicylic acid and twice distilled and ion-exchanged water. The results showed that the fluorometer reading was a linear function of the dose in the range of 150 to 400 rad. The following reagents were used for the polyacrylamide dosimeter: polyacrylamide, sodium chloride, sodium hydroxide and twice distilled and ion-exchanged water. The viscosity of an 0.04 percent solution of polyacrylamide was measured. The results showed that the viscosity change was a linear function of the dose in the range of 10^3 to 10^4 rad. (FI)

18345 USE OF AGFACONTOUR FILM FOR RECORDING ISODOSES. Anttila, P.; Rekonen, A. (Central Hospital, Jyvaskyla, Finland). pp 83-85 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

A new direct method is introduced to record photographically isodose distribution. It uses Agfacontour® film and does not require film densitometry. (FI)

18346 RADIATION MEASURING APPARATUS. Uotila, I. (Tampere Central Hospital, Finland). pp 194-196 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

Baldwin–Farmer ionization chambers for measuring dose distributions in water for radiotherapy dose planning are described. (WHK)

18347 IMPROVED RADIATION MONITORING BY MEANS OF FLUORIDE BASED GLASSES. Kaes, H. H. (Leitz GmbH, Wetzlar, Ger.). Umsch. Wiss. Tech.; 73: No. 10, 310(1973). (In German).

The technological and dosimeter properties of a newly developed fluoride-based (70% LiF) photoluminescent glass are described. This glass is less energy dependent and the recorded dosage is made more stable against ultraviolet light and thermal effects. (GE)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 17949 and 17983.

18348 (CONF-700705-(Vol.2), pp 745-752) MEASUREMENT OF FAST NEUTRON SPECTRA (~14 MeV) BY THE PHOTOEMULSION METHOD WITH A HIGH ENERGY RESOLUTION. Automatization of Measurements. Belovitskii, G. E.; Voronkov, A. E.; Kolesnikova, L. N.; Latypova, R. A.; Sukhov, L. V.; Shtranikh, I. V. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A technique for measurement of fast neutron spectra by recoil protons is based on nuclear photoemulsions. With this technique a high-energy resolution of 250 to 300 keV may be achieved, exceeding that of 450 keV obtained by the time-of-flight method. A brief description of a semi-automatic readout apparatus is given. The reliability is ensured by the application of simple electron-contact cascades in the schemes and by conjunction in many cascades of a total number of functions (counting, return, perforator outlet, interpolator outlet, etc.). (auth)

18349 (N-73-17575) ELECTRON–PROTON SPECTROMETER DESIGN SUMMARY. (Lockheed Electronics Co., Inc., Houston, Tex. (USA). Houston Aerospace Systems Div.). Jun 1972. Contract NAS9-11373. 147p. (NASA-CR-128702). NTIS.

The electron–proton spectrometer (EPS) will be placed aboard the Skylab in order to provide data from which electron and proton radiation dose can be determined. The EPS has five sensors, each consisting of a shielded silicon detector. These provide four integral electron channels and five integral proton channels from which can be deduced four differential proton increments. (auth)

18350 (TID-26371) PROFIL, AN ON-LINE PROGRAM USED TO FIT GAUSSIAN-LIKE DATA. Concaildi, G. A. (Argonne National Lab., Ill.). 4 Apr 1973. 7p. Dep. NTIS $3.00.

The program PROFIL is used to determine the FWHM size of the external proton beams. After the data from the SWICS or SWEMS are stored on the disk units, PROFIL will retrieve it and attempt to fit the function $y = Ae^{-B|x-c|^D} + E$ to the data. If halo is suspected, a slightly different function is used: $y = Ae^{-B|x-c|^D} + Fe^{-G|x-H|^I} + E$, namely, the sum of two gaussian-like curves. By the judicious adjustment of the coefficients, a good fit to the data can usually be attained. The cooperation of PROFIL is described. (WHK)

18351 (UCRL-50007-72-3, pp 13-16) INSTRUMENT DEVELOPMENT. 29 Mar 1973.

In hazards control progress report No. 44.

The effects of altitude on the sensitivity of a gas flow proportional counter for monitoring tritium in urine is discussed. Correction factors to be used for various heights are given. An updated computer program that calculates the signal squared to background ratio for gamma-ray detectors is discussed. A computer program for the analysis of NaI(Tl) gamma-ray spectra is discussed. The performance of a ^{3}He gas-filled proportional counter for neutron spectra is discussed. A computer program for fitting spectra using Gaussian or variable Gaussian-like peak shapes is described. (TFD)

18352 EXPERIMENTAL TECHNIQUES. Stirling, G. C. (Science Research Council, Chilton, Eng.). pp 31-48 of Chemical Applications of Thermal Neutron Scattering. Willis, B. T. M. (ed.). London; Oxford Univ. Press (1973).

The subject is covered in sections: general features of neutron beam experiments (units, sources, energy (wavelength) selection, detectors, shielding, polarized neutrons); instruments for neutron elastic scattering (powder diffractometer, single-crystal diffractometer, diffuse scattering time-of-flight apparatus); and instruments for neutron inelastic scattering (triple-axis spectrometer, beryllium-filtered-detector spectrometer, twin-chopper spectrometer, beryllium-filtered-beam spectrometer, rotating-crystal spectrometer). (UK)

18353 SEMICONDUCTOR DETECTOR AND ITS MANUFACTURE. Peyre-Lavigne, A.; Peyre-Lavigne, M. (to Commissariat a l'Energie Atomique). French Patent 2,129,814. 15 Mar 1971. 7p. (In French).

A surface barrier type semiconductor detector intended for operation in the avalanche regime and suitable for low energy x-ray spectrometry is presented. The manufacturing process adopted improves the characteristics of these detectors (with or without guard rings) and increases their lifetimes in the avalanche regime by minimizing the breakdown phenomena due to edge effects. The detector consists of a metallic (Au or Al) deposit made on one face of a semiconductor substrate (n type silicon or p type silicon respectively). An essential feature of this detector is the fact that the thickness of the deposit diminishes from the center toward the edges. In the case where the detector contains, in addition, a guard ring around the metallic deposit constituting the central electrode, the guard ring may also be in the form of a metallic deposit whose thickness diminishes progressively at the edges. The metallic deposit is made by vaporization under vacuum across a silicon mask provided with an orifice defined by a chamfered edge (45 deg) open toward the semiconductor substrate. (FR)

18354 DEVICE FOR DETERMINING THE ENERGY OF A SOURCE OF RADIOACTIVE RADIATIONS. Kimmel, H. German Patent 1,614,006. 2 Jan 1970. Filed Date 11 May 1967. (In German).

A device is described for measuring the energy of a radiation source divided into energy stages containing at least two indicators mounted on the radiation path characterized by the fact that one indicator is connected by an excited anticoincidence circuit to another indicator with a device for measuring and at least one indicator is connected by a coincidence circuit to another indicator with a measuring device. (EJH)

18355 SERVO-CONTROLLED RECTILINEAR VIBRATION GENERATOR PARTICULARLY SUITABLE FOR MOESSBAUER EFFECT SPECTROMETRY. Imbert, P.; Lericque, J. F. (to Commissariat a l'Energie Atomique). French Patent 2,135,998. 8 Mar 1972. 15p. (In French).

A rectilinear vibration generator intended for Moessbauer effect spectrometry is presented. The vibration speed is controlled by a servosystem. The apparatus consists of a vibration generator, a servomechanism system, a γ-ray detector device, and a multiscale counter device, whose exploration cycle is synchronized with the vibration speed cycle thus permitting the radiation flux traversing the absorber compound to be determined as a function of the velocity of the source. The most suitable vibration generators are of the servo-controlled electromagnetic type. They consist of a moving coil, which moves (as in a loud speaker) in a magnetic gap and are provided with a velocity pick up device, which is indispensable for the rigorous control of the motion using servo-techniques. The pick up device is of the moving coil or moving magnet type. (FR)

High Energy Physics Instrumentation

Refer also to abstract 19022.

18356 (AD-757462) HIGH SPATIAL RESOLUTION MULTIWIRE PROPORTIONAL CHAMBER SYSTEMS USING ELECTROMAGNETIC DELAY LINE READOUTS. Swanson, F. R.; Kuehne, F. J.; Favale, A. J. (Grumman Aerospace Corp., Bethpage, N. Y. Research Dept.). Feb 1973. 1p. (RM-569-J). NTIS.

Results of an investigation to develop multiwire proportional chamber systems using electromagnetic delay lines for high resolution cosmic ray experiments are described. The delay line used is a plexiglas core type, with a delay constant of 7 nsec/mm. The interpolation properties of this readout scheme resulted in a measured spatial resolution of 75 microns (HWHM) using iron-55 x rays and a wire spacing of 1 mm. Tracking accuracy over a 6 mm region near the center of the chamber was better than plus or minus microns when fitted to a linear spatial dependence combined with a sinusoid of wire-spacing periodicity. (auth)

18357 (CONF-700705-(Vol.1), pp 35-48) PRODUCTION OF SILVER BROMIDE MONOCRYSTALS IN THE PRODUCTION (PRECIPITATION) OF IONOGRAPHIC EMULSIONS OF THE MONTREAL TYPE. Demers, P. (Univ. of Montreal). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A method of preparing emulsions consisting of silver bromide and gelatin is described. Data are given on the grain size and number, the average grain size being 0.06 μ. Characteristics of the emulsions for detection of heavy cosmic particles are discussed. (WHK)

18358 (CONF-700705-(Vol.1), pp 59-63) VARIATION IN GRAIN DENSITY IN NUCLEAR EMULSIONS FOR EXTREMELY RELATIVISTIC PARTICLES. McNulty, P. J.; Congel, F. J. (Clarkson Coll. of Tech., Potsdam, NY). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Ilford K-5 emulsions were irradiated with a high-energy bremsstrahlung beam, a 5-GeV/c mixed proton-pion beam, and 8-, 12-, and 24-GeV proton beams. Blob density versus depth profiles were constructed for the emulsions, and these curves were extrapolated and converted to grain density. (WHK)

18359 (CONF-700705-(Vol.1), pp 65) RELATIVISTIC INCREASE OF IONIZATION AND NUCLEAR EMULSION SENSITIVITY. Kotenko, L. P.; Merzon, G. I.; Ermilova, V. K. (Lebedev Inst. of Physics, Moscow). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

It is shown that the Bethe–Bloch formula involving density effect correction is not able to describe properly the energy dependence of track density of relativistic charged particles in nuclear emulsions. The assumption that track density is proportional to restricted energy loss in silver bromide is found to be in contradiction with experimental data, because it does not allow to explain both the observed relativistic rise and grain density. The expected grain density of relativistic tracks in nuclear emulsion is calculated on the basis of energy transfer distribution in collisions with silver bromide crystals and development probability of activated crystals taking into account multiple collisions. The calculated grain density and its energy dependence are in agreement with experimental observations. The following conclusions also are made. (1) The less sensitive the nuclear emulsion, the more relativistic the rise of track density, and vice versa, but this relativistic increase is independent of the nuclear emulsion dilution. (2) The relativistic rise of ionization in nuclear emulsions is independent of the silver bromide crystal size. (3) The track density of fast particles reaches the plateau when the relativistic factor $\gamma = 50$ to 60 and almost does not change with sensitivity of nuclear emulsion. (4) The energy threshold of silver bromide crystal sensitivity is not more than 90 eV and presumably is as low as 20 to 30 eV. (auth)

18360 (CONF-700705-(Vol.1), pp 83-88) MEASUREMENTS IN NUCLEAR EMULSIONS EXPOSED TO MUONS AT 6 GeV/c AND 12 GeV/c. Coupat, B.; Michel, B.; Montret, J. C.; Vazeille, F. (Laboratoire de Physique Nucleaire Fondamentale et Developpement, Clermont-Ferrand, France). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The Coulomb scattering factor at high energy was determined, and a criterion for the selection of events in nuclear emulsions exposed to high flux (1.6×10^6 particles/cm^2) was demonstrated by means of the same principle of measurement currently used in multiple Coulomb scattering. (tr-auth)

18361 (CONF-700705-(Vol.1), pp 259-262) EXPOSURE OF IONOGRAPHIC EMULSIONS AND PLASTIC DETECTORS AT THE ISR. Research on the Magnetic Monopole and Antiparticles. Annoni, H. (CNRS, Strasbourg); Cordaillat, A. 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The use of nuclear emulsions and dielectric track detectors for elementary particle detection at the intersection region of the CERN ISR is considered. Stopped particle detection, star production, and magnetic monopole detection are briefly discussed. (WHK)

18362 (CONF-700705-(Vol.1), pp 297-312) CURRENT PROBLEMS IN COSMIC-RAY PHYSICS. Shapiro, M. M.; Silberberg, R. (Naval Research Lab., Washington, DC). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Attention is focused on some unsettled questions and new areas of cosmic-ray physics to which techniques of visual detection can make significant contributions. In particular, the following subjects are discussed: (A) the light elements and the problem of cosmic-ray lifetime; (B) nature of the path-length distribution, with special reference to the L/M ratio at intermediate energies; (C) abundances of elements with $Z \geq 15$, and especially within the Fe group; (D) cosmic-ray composition at energies ~100 MeV/nucleon; (E) the primordial composition of cosmic-ray matter; and (F) the ultra-heavy elements. (auth)

18363 (CONF-700705-(Vol.1), pp 313-338) ULTRA HEAVY COSMIC RAY NUCLEI. Fowler, P. H.; Kidd, J.; Kobetich, E.; Thorne, R. (Univ. of Bristol, Eng.). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Methods for photographic emulsion particle track analysis and interpretation in the search for heavy primary cosmic ray nuclei are discussed. Topics include measurement of track density, charge dependence, assignment of charge to individual nuclei, and the measured charge spectrum of cosmic nuclei. (WHK)

18364 (CONF-700705-(Vol.1), pp 347-362) HIGH ENERGY NUCLEAR INVESTIGATION BY PHOTOEMULSION METHOD. Zhdanov, G. B. (Space Research Inst., Moscow). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

High-energy interaction studies with nuclear emulsions at the Serpukhov Synchrotron are discussed including angular distribution of multiple particle production by π^--mesons, momentum measurements of inelastic interactions, and photoemulsion experiments in magnetic fields, also, methods for high-energy cosmic ray interaction studies are briefly discussed. (WHK)

18365 (CONF-700705-(Vol.1), pp 397-401) MEASUREMENTS OF TRACKS OF HEAVY COSMIC RAYS IN POLYCARBONATE PLASTIC DETECTORS. Enge, W. (Univ., Kiel); Bartholomae, K. P.; Fukui, K. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Charged particle determination in polycarbonate track detectors using the restricted energy loss criterion is discussed. The charge and energy of neon ions of 110 to 190 MeV/μc up to iron ions of 180 to 320 MeV/μc were measured in a stack of Zelux polycarbonate plastic. The etching procedure and the method of charge determination are discussed. (WHK)

18366 (CONF-700705-(Vol.1), pp 423-428) STUDIES OF THE NEGATIVE PION BEAMS BY MEANS OF PLASTIC NUCLEAR TRACK DETECTORS. Benton, E. V. (Univ. of San Francisco); Curtis, S. B.; Raju, M. R.; Tobias, C. A. 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Plastic nuclear track detectors, cellulose nitrate, cellulose triacetate, and polycarbonate have been exposed to fast and stopping beams of negative pions. It has been ascertained that the detectors will be useful in measuring the high LET particles emitted in the capture of the negative pions by light elements. (auth)

18367 (CONF-700705-(Vol.2), pp 809-816) SOME REMARKS ON GRAIN DENSITY. Medina, J.; Fernandez, F.; Dura, A.; Gandia, V. (Univ. Autonoma, Barcelona). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The determination of grain density in nuclear emulsions as a function of the particle velocity is studied for particle discrimination. Delta-ray theory is incorporated in the calculations. (WHK)

18368 (FRNC-TH-372) DEVELOPMENT OF PATTERN RECOGNITION METHODS FOR BUBBLE CHAMBERS. Study of Hypercharge Exchange Reactions at 4 GeV/c. Videau, H. (Paris Univ., Orsay (France)). 1972. 224p. (In French). Dep. NTIS (U. S. Sales Only) $13.25.

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

An analytical study is presented on pattern recognition for bubble or streamer chambers designed to resolve problems concerning the processing of information by automatic measurements. The principles of the filtering methods developed to process the digital images provided by an HPD are outlined. The method described is designated the single point correlation method, the usual histogram based method being called the zero point correlation method. A point-signal correlation function, H, its properties, its construction, and the types of filtering used are defined. The weightings are estimated from the numerical distributions. Methods are described for reducing the number of parameters of a pattern and for separating the signals. The validity of the filtering algorithms is discussed in terms of the results obtained. The method is used to process the results of the following hypercharge exchange reactions $K^- + p \rightarrow Y + M$ ($Y = \Lambda$ or Σ^0 and M = ω, rho, phi, f^0 or f^*) at 4 GeV/c. A method is presented for analyzing the states of polarization in $0^- + 1/2^+ \rightarrow 1/2^+ + x$ reactions. An SU_3 octet exchange model is used to describe reactions in which the baryonic vertex is given. Reactions in which a Λ system is produced are compared with those resulting in a Σ^0M system. (FR)

18369 (NP-19815) STUDY OF A DETECTOR FOR HIGH-ENERGY PARTICLES: THREE-DIMENSIONAL PROJECTION CHAMBER. Breskin, A. (Grenoble Univ. (France)). 30 May 1972. 146p. (In French). Dep. NTIS (U. S. Sales Only) $9.50.

Thesis.

The history and theory of the development of spark chambers is reviewed. The development and construction of a new type of visual detector, a multi-interval projection chamber, is then described in detail. This chamber consists of an ensemble of electrodes on which pulses of opposed polarity are applied alternately. A much lower high-voltage pulse than in the usual three-dimensional spark chambers is needed to spark the electrodes because of the shorter distance between them. (JSR)

18370 MULTIPARTICLE SPECTROMETER MAGNET (MPS). Halik, E. E. (Brookhaven National Lab., Upton, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS 20: No. 3, 740-741(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

During the last few years more and more Spectrometer Magnets were employed in high energy physics experiments. Most of these experiments detected a relatively small number of particle secondaries because the apertures of the magnets were not satisfactorily large. For this reason an attempt is being made at BNL to build a spectrometer which could accommodate experiments on more complicated types of interactions with detection of many secondaries. Obviously this spectrometer, in order to perform properly, will be large and with an acceptable magnetic field; it must have better resolution, and a wide solid angle acceptance. The basic idea is a large aperture C-magnet. High resolution digitized spark chambers, low mass proportional chambers and scintillation counter hodoscopes will be located and operated within the magnetic field volume which will be 4-ft high by 6-ft wide by 15-ft long. The main spectrometer is to be followed by a set of large digitized spark chambers, scintillation counter hodoscopes, and Cherenkov counter hodoscopes to provide improved momentum resolution and particle identification for those particles which emerge through the downstream aperture of the magnets. This magnet spark chamber combination will give the experimenter freedom to move to a new class of experiments. (auth)

Radiometric Instruments

Refer also to abstracts 18242, 18758, and 18835.

18371 (INIS-mf-660/8, pp vp Paper 3) SELECTED RADIOISOTOPE GAGES OF THE VEB RFT MESSELIEKTRONIK "OTTO SCHOEN" DRESDEN FOR THE RATIONALIZATION OF INDUSTRIAL PROCESSES. Schubert, G. (VEB RFT Messelektronik "Otto Schoen," Dresden). 1972. (In German).

From international nuclear industries fair; Basel, Switzerland (16 Oct 1972).

The fabrication and performance of radiometric densimeters, level indicators, and thickness gages are discussed. (INIS)

18372 (INIS-mf-660/8, pp vp Paper 4) INDUSTRIAL APPLICATIONS OF RADIOISOTOPE GAUGES. Wierzchowski, M. (POLON Nuclear Equipment Establishment, Warsaw). 1972.

From international nuclear industries fair; Basel, Switzerland (16 Oct 1972).

There are some technological processes where the beta and gamma radiation are the only means to penetrate matter in order to investigate its physical character. Some of the most interesting isotope measuring instruments and controllers are described. (INIS)

18373 DUAL SOURCE GAMMA RAY TRAVERSING MECHANISM SUITABLE FOR THE NON-DESTRUCTIVE SIMULTANEOUS MEASUREMENT OF BULK DENSITY AND WATER CONTENT IN COLUMNS OF SWELLING SOIL. Bridge, B. J. (Central Region Agricultural Centre, Chainat, Thailand); Collis-George, N. Aust. J. Soil Res.; 11: No. 1, 83-92(Mar 1973).

A traversing mechanism is described in which 100 mCi sources of americum-241 and cesium-137 are alternately brought into line with a sodium iodide (thallium) scintillation counter connected to a single-channel pulse height analyzer equipped with two preset base lines. The equipment is capable of scanning a 10 cm diameter soil column equipped with sensors to a height of 200 cm, and facilities are provided for automatic indexing at preset intervals to an accuracy of 0.01 cm. Non-linear counting losses in the spectrometer system are described, and were found to be dependent on the window setting of the pulse height analyzer. With the window setting adjusted to cover the apparent spread of the gamma peak, counting losses were negligible. Mass absorption coefficients of various materials were obtained using a compartmented box. Measured mass absorption coefficients of water, silica sand, and a chernozemic soil were 0.201, 0.247, and 0.303 $cm^2\ g^{-1}$ respectively for americum-241, and 0.0826, 0.0746, and 0.0728 respectively for cesium-137. The precision of the apparatus was demonstrated by determining the moisture characteristic and bulk density characteristic of 0.5 to 1 mm aggregates of Narrabri soil during absorption and desorption. Gamma ray attenuation measurements and direct volumetric measurements were comparable. The standard deviations in the gamma ray measurements were found to be 0.03 g cm^{-3} for bulk density and 0.04 $cm^3\ cm^{-3}$ for water content. Most of this inaccuracy arose from lack of precision in the americum-241 mass attenuation coefficient for the soil. By contrast, changes in moisture content and bulk density, at any level, of 0.004 $cm^3\ cm^{-3}$ and 0.004 g cm^{-3} respectively, were statistically very significant. (auth)

18374 SMOKE AND COMBUSTION GAS DETECTOR. (to Gamma Electronique). French Patent 2,142,609. 22 Jun 1971. 11p. (In French).

A smoke, gas, or aerosol detector is presented which incorporates two ionization chambers (electrically connected in series). The apparatus is designed in such a way as to allow instantaneous adjustments to be made to the sensitivity, the neutralization of false alarms, and the indication of functional defects. The power supply used is 50 V or less. (FR)

18375 RADIATION GAUGES FOR DENSITY, THICKNESS, AND LEVEL MEASUREMENT. Sakaki, M. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Denshi Tenbo; 9: No. 4, 68-72(Apr 1972). (In Japanese).

Various radiation gages are introduced from a viewpoint of new sensors. Use of these gages has rapidly increased in these several years because of their advantages, i.e., fast, easy, non-contact and non-destructive measurement, availability of on-line continuous measurement, and less influence from the conditions such as temperature, pressure, viscosity and traveling speed of objects. Density gages are employed in widespread fields such as petroleum, mining, metal, cement, and civil engineering and construction industries. Thickness gages must be properly applied according to purpose. The gages are also divided into two categories: transmission type and back scattering type. Level gages are used for the level measurement of reaction towers, raw material tanks, and hoppers. As the sensors that utilize radiation other than the above, there are neutron moisture gages, sulfur analyzers and calorimeters for fuel oil and others. (JA)

18376 GAMMA-RAY MONITORING OF SEDIMENT CONSOLIDATION TESTS. Maus, L. D.; Rose, V. C.; Nacci, V. A. (Univ. of Rhode Island, Kingston). Ocean Eng.; 2: No. 4, 195-205(Jun 1973).

A gamma-ray transmission method for measuring the water content of marine sediment samples during consolidation testing is presented. This method permits obtaining consolidation curves for sediment cores while still in the core liner, thereby eliminating several sources of sample disturbance. A narrow beam of gamma rays is passed through the sample to a detector and counting equipment. The attenuation of this beam is a function of the sample density and hence water content or void-ratio. Equations are developed for calculating water content from gamma-counts. The results of experiments are presented confirming the validity of the equations. (auth)

18377 GROUND TRAIL PROBE FOR THE MEASUREMENT OF GAMMA DENSITY ON OCEAN BEDS. Abdullah, H. (Tech-

nische Univ., Clausthal, Ger.). Meerestechnik; 4: No. 3, 87-89 (1973). (In German).

For density determinations in the upper centimeters of the ocean beds, a ground trail probe was designed incorporating a measuring system according to the principle of the gamma-gamma-density measurements (^{60}Co, ^{137}Cs) which was tested in shallow waters in the summer 1972. The principle of operation, the probe, and the results of measurements are described. (GE)

18378 ON-LINE ASH CONTENT DETERMINATION. Goettsching, L. (Technische Univ., Darmstadt, Ger.); Bauer, J. Papier (Darmstadt); 26: No. 10A, 574-585(1972). (In German).

Quality and economic reasons demand a continuous control of the ash content of filler-loaded papers during production. Several possibilities for a non-destructive continuous evaluation of the ash content of running paper webs are discussed. Following a brief outline of the most important theoretical principles, the measuring methods with the best prospects for an on-line application are compared. Such methods are measuring of the backscatter intensity of a β-radiation and the γ- radiation absorption in an irradiation measuring arrangement. An on-line ash content measuring device is described, which recently has become commercially available. The principle of this measuring method is the registration of the absorption of low-energy γ-radiation during the penetration of the filler-loaded paper web. A prototype of this device underwent an empirical performance test. A report on the results of this investigation is given. In order to test the performance of the device, the reproducibility and relative exactness of the measured ash-contents, experiments were made in the laboratory on stationary and moving paper webs. The good performance results thus obtained were confirmed in extensive field tests on two fine paper machines. Regression analyses of the measurement results obtained by the device showed a variation of only 1.1% during the paper machine experiments with a statistic safety of 95% related to the ash content determined gravimetrically. (GE)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

18379 (N-73-17215) RADIATION EFFECTS ON THREE LOW POWER MICROCIRCUITS. Yamakawa, K. A. (Jet Propulsion Lab., Pasadena, Calif.). 15 Nov 1972. Contract NAS7-100. 30p. (NASA-CR-130750; JPL-TM-33-576). NTIS.

Irradiation of several low power circuit elements by Co-60 gamma radiation, low and high energy electrons, and neutrons is discussed. The bipolar circuits were SE480 Q NAND gate, and a micropower frequency divider used in electronic wrist watches. The MOS device was a dual p-channel MOSFET. (STAR) (auth)

18380 (SLA-73-5336) TRANSIENT CHANGE IN Q AND FREQUENCY OF AT-CUT QUARTZ RESONATORS FOLLOWING EXPOSURE TO PULSE X-RAYS. King, J. C.; Sander, H. H. (Sandia Labs., Albuquerque, N. Mex.). 1973. 12p. (CONF-730703-7). Dep. NTIS $3.00.

From conference on nuclear and space radiation effects; Logan, Utah, USA (23 Jul 1973).

Study of the transient behavior of the AT-cut quartz resonators following pulsed irradiation has been extended. In addition to 125 MHz 5th overtone crystal units previously reported, both 32 MHz and 5 MHz 5th overtone units have been studied using several different oscillator circuits, one of which is designed to give the transient resistance at series resonance, R_s, as well as frequency as a function of time after pulse exposure. R_s is proportional to the acoustic loss, i.e., Q^{-1}, of the resonator. With but one notable exception, the annealing kinetics of the transient frequency offset following pulse irradiation obeys a $t^{-\frac{1}{2}}$ relationship over three to four decades in time, indicative of a ID diffusion limited trapping of uncorrelated defects in the crystal lattice. The most significant observations of the post-irradiation behavior of R_s is the relatively large R_s increase in natural quartz resonators. The transient increase anneals asymptotically to a relatively stable R_s value which is somewhat higher than the pre-irradiation R_s. The transient and steady-state post-irradiation change in R_s is frequency dependent and, based upon the underlying model, should also be temperature dependent. The increase of R_s in 5 MHz natural quartz resonators exposed to 10^4 Rad from the Sandia Laboratories' Hermes II facility is 30 times its pre-irradiation value at 0.2 sec after burst. However, R_s for 32 MHz crystal units at .2 sec after exposure to 4×10^4 Rad typically increases only a factor 2 times the pre-irradiation value. Swept synthetic crystal units show no measurable post-irradiation change in R_s whatsoever. This fact, together with the absence of any delayed, or persistent, electrical conductivity in the swept synthetic unit following pulsed ionization, leads to the hypothesis that the transient as well as the steady-state R_s increase arises from an inelastic absorption caused by Li^+ and/or Na^+ which are able to move along the optic axis with an activation energy of approximately 0.3 eV—notably the same activation energy as that observed for the delayed conductivity and for the thermal bleaching of part of A-band color centers in natural quartz. When R_s becomes very large, it can have two effects on the resonator frequency: (1) negative $\Delta f/f$ due to stress relaxation and (2) a $\Delta f/f$ whose sign depends on the transfer phase angle in the active part of the oscillator loop. Finally, it has been discovered that the transient $\Delta f/f$ can be made negligible in crystal resonators made from quartz swept in an inert atmosphere. It is now safe to speculate that specific defects in quartz can be altered in a prescribed way such as to make resonators which are insensitive not only to steady state radiation but also to intense pulse irradiation. (auth)

18381 (SLA-73-5613) LATCH-UP IN CMOS INTEGRATED CIRCUITS. Gregory, B. L.; Shafer, B. D. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 21p. (CONF-730703-8). Dep. NTIS $3.25.

From conference on nuclear and space radiation effects; Logan, Utah, USA (23 Jul 1973).

The parasitic transistors and pnpn paths present on junction isolated CMOS circuits have been identified and studied quantitatively. Active SCR structures exist which can be triggered electrically or by a radiation pulse. Detailed studies of SCR paths have been performed on two circuits, the CD4007A and the CD4041A, to relate geometrical and materials parameters to latch-up sensitivity. Both normal bias conditions and bias optimum for obtaining SCR action are employed. Several techniques are proposed to eliminate radiation-induced latch-up in future CMOS designs. (auth)

18382 DAMAGE OF C-MOS SWITCHING CIRCUITS BY IONIZING RADIATION AND ANNEALING OF THESE DEFECTS. Schambeck, W. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt eV, Oberpfaffenhofen, Ger.) (1972). vp. (In German).

From 5th international congress on microelectronics; Munich, Germany (27 Nov 1972).

The effects of irradiation on the threshold and transconductance of most recent A-series C-MOS inverter circuits CD 4007 AD from both RCA and Solid State Scientific (SSS) were studied. The circuits were irradiated with 1-MeV electrons. After irradiation up to 10^{14} e/cm^2 the circuits were annealed isochronously for 5 h at temperatures up to 345°C. The threshold voltages of A-series RCA P-channel transistors were recorded to their initial value before irradiation after 5 h at 250°C, whereas for the SSS circuits the remaining change in threshold voltage is about 1 V even at 345°C. The damage to RCA N-channel transistors cut-off during irradiation is annealed at 200°C. However, complete annealing of N-channel circuits conducting during irradiation was impossible even at 345°C. (GE)

18383 EFFECTS OF X IRRADIATION ON MAS DIODES. Nakagiri, M.; Tsujide, T. (Nippon Electric Co. Ltd., Kawasaki, Japan). Jap. J. Appl. Phys.; 11: No. 7, 1054(Jul 1972).

18384 EMF STABILITY OF CHROMEL/ALUMEL AND TUNGSTEN-3% RHENIUM/TUNGSTEN-25% RHENIUM SHEATHED THERMOCOUPLES IN A NEUTRON ENVIRONMENT. Carpenter, F. D.; Sandefur, N. L.; Grenda, R. J.; Steibel, J. S. (Gulf General Atomic Co., San Diego, CA). Contract AT(04-3)-167. pp 1927-1934 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

A method for periodically calibrating thermocouples during continuous irradiation exposure was devised to measure their emf stability in a nuclear environment. Both Chromel/Alumel and tungsten-3% rhenium/tungsten-25% rhenium sheathed thermocouples were tested while operating at temperatures between 900° and 1100°C. An internal calibration system using the fixed melting point of copper (1083°C) was used to measure emf output deviations. The thermocouples were tested in the Engineering Test Reactor at the National Reactor Testing Station, Idaho, for a period of seven months to a total neutron flux exposure of 1.6×10^{21} thermal and 2.7×10^{21} fast (E > 0.18 MeV). The emf characteristics of the Chromel/Alumel thermocouple did not degrade under the test conditions and remained within a 1.0 percent tolerance band at the copper melting temperature. The emf outputs of the tungsten-3% rhenium/tungsten-25% rhenium thermocouple degraded (became less) as the radiation progressed. At the conclusion of the experiment, the emf output of the tungsten-3% rhenium/tungsten-25%

rhenium thermocouple indicated a temperature value 85°C less than the 1083°C melting point of copper. (auth)

18385 MEASURED DRIFT OF IRRADIATED AND UNIRRADIATED W 3% Re/W 25% Re THERMOCOUPLES AT A NOMINAL 2000 K. Heckelman, J. D.; Kozar, R. P. (Lewis Research Center, Cleveland). pp 1935-1949 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

Seven tantalum sheathed, BeO insulated, 0.157 cm diameter, grounded junction W3%Re/W25%Re thermocouples were irradiated in a helium-argon environment, at a temperature of 1900 to 2100 K. Six other thermocouples from the same lot were operated out-of-pile with the same temperature history as the in-pile thermocouples. Drift in-pile was determined by periodically replacing a "reference" thermocouple in the irradiation capsule. Drift out-of-pile was determined with an optical pyrometer. After 8000 hours irradiation, the estimated neutron fluence was 4×10^{21} thermal neutrons/cm^2 and 0.9×10^{21} fast neutrons/cm^2 (E > 0.18 MeV). At this time the in-pile group had decreased in output the equivalent of 340 K at 2073 K and the out-of-pile group had decreased in output the equivalent of 54 K at 2073 K. The maximum deviation in drift between thermocouples of the in-pile group and between thermocouples of the out-of-pile group was < ± 15 K and < ± 10 K, respectively. (auth)

18386 RADIATION STABILITY OF PLASTIC SCINTILLATORS BASED ON POLYSTYRENE. Gunder, O. A.; Koba, V. S.; Ekkerman, V. M. Sov. Radiochem. (Engl. Transl.); 14: No. 6, 953-955 (1972).

Translated from Radiokhimiya; 14: No. 6, 913-914(1972).

The radiation stability of the fluorescent additives, paraterphenyl (PPP) and 2,2'-p-phenylenebis[5-phenyloxazole] (POPOP) was studied when used with polystyrene. Results indicate that the decrease in the scintillation efficiency of plastic scintillators is caused by a number of factors, including an irreversible process of damage to the polymer base and the formation of unstable radiolysis and degradation products of the fluorescent additive. The degree of the irreversible process of damage to the polymer base depends on the chemical structure of the fluorescent additive. Thus, PPP protects polystyrene from destruction, while POPOP accelerates this process. On the basis of a calculation of the degradation constants of the additives, it was established that PPP is more stable than POPOP. In the binary system PPP + POPOP, the stability of the latter is reduced, while that of PPP is increased on account of a transfer of energy of excitation from PPP to POPOP. A $^{90}Sr-^{90}Y$ source of β radiation was used. (JGB)

Miscellaneous Instruments

Refer also to abstracts 18213, 18620, 18782, 18832, 18935, 19125, 19126, 19902, 20063, 20281, 20284, 20294, 20319, 20320, 20340, and 20404.

18387 (LMSC-D-243287) DEVELOPMENT OF X-RAY CONVERSION PHOSPHORS. Fifth Annual Report, (Task II). Buchanan, R. A.; Sobon, L. E.; Alves, R. V.; Maple, T. G. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). Aug 1971. Contract AT(04-3)-836. 70p. Dep. NTIS $5.50.

A new x-ray conversion phosphor, Gd_2O_2S:Tb, has been developed for use in x-ray image intensifier tubes. The characteristic properties of this new material are compared with those of Cd, ZnS:Ag and CsI:Na, which are currently being used in commercial x-ray image intensifier tubes. These comparisons show that the newly developed Gd_2O_2S:Tb phosphor is a superior material for this application. As a result of this work, Machlett Laboratories has developed an x-ray image intensifier tube using the Gd_2O_2S:Tb phosphor. Gd_2O_2S:Tb x-ray intensifying screens are evaluated for use in diagnostic medical radiography. A comparison of Gd_2O_2S:Tb and $CaWO_4$ screens indicates that with further phosphor and film development this new material may make possible an order of magnitude increase in sensitivity over presently used $CaWO_4$ screen film combinations. A theoretical investigation of the properties of particulate x-ray conversion screens has been carried out in order to guide the experimental development program described. A computer program has been written to calculate x-ray screen performance as a function of several variables. Preliminary results from these calculations are presented and the calculation itself is reproduced. Further work is required to verify experimentally the theoretical calculations. When this is accomplished, this computer program will make it possible to design the optimized screen for any x-ray conversion application. (auth)

18388 (MLM-2072) FDSR (ARG1,ARG2): A FOCAL PATCH FOR ACCESS TO THE NUCLEAR DATA 50/50 DATA STORAGE REGISTER. Haas, F. X. (Mound Lab., Miamisburg, Ohio). 30 Jul 1973. Contract AT-33-1-Gen-53. 11p. Dep. NTIS $4.00.

This program will retrieve and deposit data into the data storage register of the Nuclear Data 50/50 analyzer. Program listings are given for use with FOCAL, 1969, with and without extended functions, and FOCAL 5/69. (auth)

18389 (TID-26352) STUDY OF RARE EARTH ACTIVATED MATERIALS FOR RADIATION-SENSING APPLICATIONS. Third Annual Report. Wickersheim, K. A.; Buchanan, R. A.; Sobon, L. E.; Alves, R. V.; Pearson, J. J. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). Jun 1969. Contract AT(04-3)-674. 68p. Dep. NTIS $5.50.

Research on the preparation and properties of the yttrium oxide class of rare earth phosphors for use in scintillation counting and x-ray conversion is described. Topics include preparation and optimization of La_2O_2S:Tb phosphor powders, crystal growth of lanthanum oxysulfide cathodeluminescence of La_2O_2S:Tb phosphors, crystal field studies and high resolution spectra of La_2O_2S:Tb, and x-ray excitation of La_2O_2S:Tb. (WHK)

18390 (UCRL-50007-72-3, pp 11-12) MEASUREMENT OF BORRMANN ANOMALOUS TRANSMISSION ON Ge AND CdTe CRYSTALS. Pickles, W. L.; Elliott, J. H. 29 Mar 1973.

In hazards control progress report No. 44.

The transmission of a 1-mm thick germanium crystal at about 17 keV and the passband shape in a particular geometry were studied for the development of an x-ray filter for use in x-ray fluorescence analysis. (TFD)

18391 PERMANENT MAGNET PROBE FLOWMETER. Wood, M. R.; Duane, B. H.; Lessor, D. L. (to United States Atomic Energy Commission). U. S. Patent 3,736,798. 5 Jun 1973. Filed date 24 Jun 1971. 4p.

A probe-type flowmeter for measuring the flow of conducting fluids, in particular liquid sodium, is described. The probe includes a permanent magnet for developing a magnetic flux and a pair of conductors coupled to a metering device for measuring the emf developed in the conducting fluid. The magnitude of the emf is a function of the fluid velocity. (Official Gazette)

18392 HYDROGEN ACTIVITY METER. Vissers, D. R.; Holmes, J. T.; Nelson, P. A. (to United States Atomic Energy Commission). U. S. Patent 3,731,523. 8 May 1973. Filed date 23 Feb 1971. 8p.

A device for measuring the hydrogen concentration in liquid sodium is described. A thin-wall, tubular, annealed nickel probe in contact with liquid sodium is connected to an ion pump and a vacuum gauge. A vacuum is created within the nickel probe by the ion pump, which thereafter is isolated from the remainder of the device. Hydrogen atoms in the liquid sodium diffuse through the wall of the probe and into the interior thereof until an equilibrium between hydrogen atoms within the probe and hydrogen atoms in the liquid sodium is obtained. Such diffusion by hydrogen atoms into the probe results in a pressure change within the probe. The pressure change occurring between the time of initial probe evacuation and the time equilibrium of the hydrogen atoms is obtained is measured by the vacuum gauge, and this pressure change is indicative of the hydrogen concentration in the liquid sodium. (Official Gazette)

18393 NEWER THERMOCOUPLE MATERIALS. Zysk, E. D.; Robertson, A. R. (Engelhard Minerals and Chemicals Corp., Menlo Park Edison, NJ). pp 1697-1734 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). CONF-710604-(V4)(P3).

The present status of non-standard thermocouple materials is reviewed. It covers couples intended for cryogenic temperatures, moderate temperatures (to 1000°C), intermediate temperatures (to 1600°C) and high temperatures (to 3000°C). Metal and non-metal thermoelements are discussed. Wherever possible nominal emf vs. a standard material is given for some of the newer thermoelements. The properties of newer ceramic insulating materials (beryllia, ceria, thoria, hafnia, and boron-nitride) and of sheath materials intended for high temperature use (1400 to 2600°C) are briefly discussed. Included in the latter category are noble and refractory metals, oxide-strengthened metals and alloys, cermets and ceramics. Sources of information are the published literature, private communications and unpublished work performed in the authors' laboratory. (169 references) (auth)

18394 TUNGSTEN-RHENIUM THERMOCOUPLES: SUMMARY REPORT. Anderson, T. M.; Bliss, P. (United Aircraft Corp.,

East Hartford, CT). pp 1735-1746 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

More than a decade has passed since the introduction of W–Re thermocouples. During this period the need for temperature measurements in excess of 1600°C has continued unabated. It seems appropriate at this time to review what progress has been made and examine existing problems. The three most common W–Re thermocouple alloys are described. Common fabrication techniques are discussed. Problems associated with applying the thermocouple are described. Particular emphasis is given to oxidation protection. Measurement limitations imposed by presently available ceramics are reviewed. A discussion of some present needs is given from the viewpoint of an industrial user. (37 references) (auth)

18395 EQUIVALENT CIRCUIT MODELING OF INSULATOR SHUNTING ERRORS IN HIGH TEMPERATURE SHEATHED THERMOCOUPLES. Shepard, R. L. (Oak Ridge National Lab., TN); Hyland, R. F.; Googe, J. M.; McDearman, J. R. pp 1841-1853 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

Temperature indication errors up to 10 percent at 2700°K can be caused by a decrease of the resistivity of the insulator material which separates the wires in a typical high-temperature sheathed thermocouple. Various 2-wire equivalent circuit models have been proposed whose behavior approximately predicts shunting errors where material properties and temperature gradient shapes are known. A 3-wire model of a sheathed thermocouple was devised that includes the contribution of the sheath to the shunting error. This model was used to correct shunting errors to less than 1 percent for various materials, configurations, and known temperature gradient shapes. By use of this model, supplemental cold-end measurements such as loop resistance and loop-to-sheath resistance were made on a shunting thermocouple which helped to reduce the ambiguity of the error correction. A method was devised for obtaining true temperatures from a shunting thermocouple in an unknown temperature gradient by profiling, i.e., by inserting the thermocouple into the gradient incrementally. (24 references) (auth)

18396 TESTING OF CERAMIC INSULATOR COMPACTION AND THERMOELECTRIC INHOMOGENEITY IN SHEATHED THERMOCOUPLES. Carr, K. R. (Oak Ridge National Lab., TN). pp 1855-1866 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

Test methods were developed and applied to determine the ceramic insulator compaction and thermoelectric inhomogeneity in sheathed thermocouples. Two new reliable compaction test methods were shown to have an accuracy of ±2 percent of the maximum theoretical density (MTD) of MgO. The methods were applied to 0.16 cm outer diameter and 0.32 cm outer diameter, MgO insulated thermocouples obtained from fifteen manufacturers. The compaction values ranged from 70 to 92 percent MTD, and all material having a compaction of >78 percent MTD was obtained from manufacturers who normally reduce the sheath diameter by swaging. In the thermoelectric inhomogeneity test method, the inhomogeneity of a test thermocouple was determined by comparison with a standard thermocouple as both were immersed through a short thermal gradient and the differential output was recorded. The repeatability of the inhomogeneity test is generally within ±20 μV. The method was applied to measure inhomogeneity in type K thermocouples caused by cold work and by service at 870°C. Some sections of aged thermocouples had inhomogeneity errors as large as 35 percent when measuring a true temperature of 150°C. (auth)

18397 TEMPERATURE MEASUREMENT ON NUCLEAR FUEL ELEMENTS. Liermann, J.; Tarassenko, S. (CEN, Saclay, France). pp 1903-1914 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

The necessity of temperature measurement in nuclear reactors and irradiation devices has led to the examination of measuring devices which are compatible with conditions imposed by pressure, temperature, neutron flux, and coolant and which satisfy the requirements of fuel handling machines and handling in height activity facilities. As a result of these studies, devices have been created which are capable of measuring temperature in fuel elements as well as in the gas cooling. This is accomplished by a chain which transmits the thermoelectric signal without altering the quality of measurement. In some cases continuous thermoelectric probes have been employed with the possibility of removing them during the running of the reactor. In other cases measuring lines have been divided, the electric connections being assured by contacting devices. Problems of cabling and connection of measuring lines and of imperviousness systems have been solved as well. The fidelity of probes has been improved by an appropriate heat treatment. The measurement accuracy was obtained only after a systematic calibration. For this purpose an elaborate apparatus was put in perfect running order permitting the rapid processing of a large number of thermocouples. (auth)

18398 SOME APPLICATIONS OF DYNAMIC TEMPERATURE MEASUREMENTS IN FLUID FLOW ASSOCIATED WITH NUCLEAR REACTOR SYSTEMS. Nishihara, H.; Ohtsubo, A.; Michiyoshi, I. (Kyoto Univ.). pp 1915-1925 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

In a complex system such as a nuclear reactor or a biological body, measurements of the system variables or its characteristics should be simple, reliable and least perturbing to the system. The measurement and analysis of temperature fluctuations in such a system by thermocouples satisfies this condition. Several such examples are described. Temperature fluctuations treated here are either inherent to the system or generated by a very simple device, i.e., vortex-generating rod. Temperature fluctuation caused by the vortex street behind a heated cylindrical rod was measured both in water and mercury flow, and the fluctuation frequency was compared with the flow rate measured by a different method. The amplitude of the inherent temperature fluctuations in turbulent heat transfer was measured related to the local heat flux. The two quantities were found to have a linear dependence for a fixed thermocouple position. The system transfer function is obtainable if the input and output noise spectra are measured. In a nuclear reactor whose power feedback is through the temperature, the non-white temperature fluctuation distorts the output neutron power spectrum. In such cases measurement of temperature noise spectra helps analyze the system transfer function. Temperature noise spectra and noise equivalent sources are compared for natural convection. (auth)

18399 OBSERVATIONS ON TUNGSTEN–RHENIUM THERMOCOUPLES USED IN-REACTOR IN $(U,Pu)O_2$ FUEL PINS. Fitts, R. B.; Miller, J. L. Jr.; Long, E. L. Jr. (Oak Ridge National Lab., TN). pp 1951-1958 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

Three W–26% Re sheathed and one Mo sheathed, BeO insulated, W–3% Re/W–25% Re thermocouples have been examined. These were used to measure the temperature at the center line of $(U,Pu)O_2$ fuel pins. The thermocouples operated up to 125 hours at 2000°C and to 500 hours above 1800°C. The only difficulty encountered with the W–Re sheathed couples during operation was shorting of one thermoucouple to the sheath when the sheath collapsed into a space between two insulators. The structure of the wires and sheaths was examined after irradiation and compared with that produced in out-of-reactor heat treatment. During operation in-reactor, the W–Re wires and sheaths developed porosity. This effect was much more pronounced in the W–3% Re wires than in the high-Re wires or sheaths. Tungsten–rhenium crystals were found deposited on the BeO insulation, and BeO crystals were found on the wall of the W–26% Re sheath. Similar effects were noted in the thermocouple assemblies heated out-of-reactor and more severe attack occurred in the Mo-sheathed assembly. The observed structural changes are believed to be the result of vapor phase transport of the components of the thermocouple, probably as volatile oxides. No effect on the thermocouple output was observed. Although the tests were not specifically designed to detect such changes, any calibration shift is felt to have been less than 5 percent at 2000°C. (auth)

18400 IN-REACTOR TEMPERATURE MEASUREMENT USING MICROWAVE TECHNIQUES. Billeter, T. R. (Hanford Engineering Development Lab., Richland, WA). pp 1171-1179 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 2. Rubin, L. G. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P2).

The severe environment within advanced nuclear reactors imposes stringent requirements upon temperature measurement methods operative for extended periods of time. As a possible alternative to the customarily-used thermocouple or resistance thermometer, several schemes employing microwave frequency devices and techniques have been developed and tested. One employs a 1.75 cm outer diameter by 1.75 cm long cylindrical metal sensor resonant at about 36 GHz. As a function of temperature, the measured resonant frequency varies, yielding a nearly linear signal response from 20 to 1400°C for a high quality factor niobium–1% zirconium sensor. Frequency deviations of approximately 250 kHz/°C permit theoretical measurement accuracy of ±0.05°C, however variations of the metal expansion characteristics result in a practical accuracy of ±2 percent of the measured value. Evaluation of time response for abrupt temperature changes for a sensor of 0.25 cm wall thickness, resulted in time constants of 0.5 to 30 seconds for immersion in water and flowing helium, respectively. Another measurement method depends upon the noise emitted by a "gray body" sensor in a 20 MHz bandwidth centered at 35 380 MHz. Although a passive system, component emissivities, waveguide attenuation, and temperature distribution along the transmission medium must be known for optimum evaluation of sensor temperature. (auth)

18401 GAS FLOW MEASURING DEVICES. Anderson, D.; Caldwell, R. M. (to United Kingdom Atomic Energy Authority). British Patent 1,315,231. 2 May 1973. Filed date 28 Apr 1971. 4p.

An apparatus for detecting restrictions to gas flow through nuclear reactor fuel element channels is described. Previously gas flow measurements have been made by means of an anemometer lowered into the outlet of channels while the reactor is operating, but complex and expensive anemometers are necessary, due to the severe operating conditions. The apparatus described, which is temporarily introduced into a channel, comprises a tubular housing having a gas inlet at one end and a gas outlet at the other end, a variable inductance indicating anemometer, and an electrically driven blower mounted in the housing. Extensible support means are provided for introducing the apparatus into a channel. The apparatus is relatively simple and inexpensive and can be used when the reactor is shut down. (UK)

18402 MEASUREMENTS OF LIQUID SODIUM TEMPERATURES BY MICROWAVE TECHNIQUES. Nagatoro, Y.; Ohgushi, A. (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 10: No. 5, 320-322(May 1973).

18403 NEW PROFILOMETER BENCH DESIGNED FOR DIGITAL DATA RECORDING. Olshausen, K. D. (Institutt for Atomenergi, Kjeller, Norway). pp 93-96 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A new profilometer bench built for the Hot Laboratory at Kjeller, Norway, is described. The bench is designed for simultaneous diameter and profile measurement on irradiated fuel pins of up to 1.8 m length. The pins are inserted vertically. The translatory movement of the transducer support is accomplished by a dc-stepping motor through a rack-and-pinion drive. Counting the pulses fed to the stepping motor gives an accurate position signal on a 6-decade scaler with BCD-output. This position signal, together with the digital outputs from the two transducers, is recorded on an incremental magnetic tape recorder every 0.1 mm along the length of the pin. A computer program analyzes the recorded data and extracts the essential results. (auth)

18404 TEMPERATURE: ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY. Volume 4, Part 3. Fifth Symposium on Temperature, Washington, DC, June 21-24, 1971. Finch, D. I.; Burns, G. W.; Berger, R. L.; Van Zandt, T. E. (eds.). Pittsburgh; Instrument Society of America (1972). 903p. (CONF-710604-(V4)(P3)).

Separate abstracts were prepared for 18 of the 71 papers included. The remaining 53 papers were not within the scope of NSA. (WHK)

For abstracts of individual papers see: 18384, 18385, 18393–18399, 19274, 19275, 19360–19362, 20281, 20319, 20340, and 20404.

18405 TEMPERATURE: ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY. Volume 4, Part 2. Fifth Symposium on Temperature, Washington, DC, June 21-24, 1971. Rubin L. G.; Anderson, A. C.; Janssen, J. E.; Cutkosky, R. D. (eds.). Pittsburgh; Instrument Society of America (1972). 792p. (CONF-710604-(V4)(P2)).

Separate abstracts were prepared for 6 of the 75 papers included. The remaining 69 papers were not within the scope of NSA. (WHK)

For abstracts of individual papers see: 18400 and 19774–19778.

18406 TEMPERATURE: ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY. Volume 4, Part 1. Fifth Symposium on Temperature, Washington, DC, June 21-24, 1971. Preston-Thomas, H.; Murray, T. P.; Shepard, R. L. (eds.). Pittsburgh; Instrument Society of America (1972). 814p. (CONF-710604-(V4)(P1)).

Separate abstracts were prepared for 4 of the 69 papers included. The remaining 65 papers were not within the scope of NSA. (WHK)

For abstracts of individual papers see: 18782, 19773, 20063, and 20320.

18407 A FULLY AUTOMATIC COMPUTER-CONTROLLED MASS SPECTROMETRY SYSTEM FOR PRODUCT ANALYSIS IN URANIUM ENRICHMENT PLANTS. Habfast, K.; Kappus, G.; Heinen, G. (Varian Mat GmbH, Bremen, Ger.). Kerntechnik; 15: No. 6, 264-269(1973). (In German and English).

A fully automatic computer-controlled mass spectrometry system for measuring the U-235/U-238 isotope ratio in uranium hexafluoride is described. The system is intended for production monitoring in uranium enrichment plants. A measuring accuracy of better than 0.04% of the isotope ratio, at a statistical confidence level of 95%, was reached in continuous operation over several hundred hours. (GE)

18408 VECTOR SYSTEM OF INSTRUMENTS AND UNITS FOR NUCLEAR ELECTRONICS. Kurochkin, S. S.; Kiselev, L. G.; Murin, I. D. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr.; 18: 90-103(1972). (In Russian).

The features of the "Vector" system of instruments and units for nuclear electronics of the third generation are examined. High-precision microcomponents and discrete elements of precision printed circuitry are the basis of the "Vector" system. According to the principles of construction, the logic functions, norms for signals and junctions of the "Vector" system are similar to the foreign systems CAMAC and NIM; however, the system is designed on the basis of native standards and completed articles. The features of the system connected with this and accepted norms of projection are considered. The structure of the system and the basic characteristics of its instruments and units are analyzed. (JPRS)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

18409 (JUL-939-NP) COMPUTER SIMULATION OF THE MOTION OF HEAVY IONS PASSING THROUGH GAS FILLED ELECTROMAGNETIC SEPARATORS. Fiebig, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik). Mar 1973. 84p. Dep. NTIS (U. S. Sales Only) $6.25.

The Monte-Carlo technique was used to study the motion of heavy ions passing through gas-filled electromagnetic fields taking into account energy loss, change of the ionic charge, and deflection due to multiple scattering. The energy loss is treated in the continuous-slowing-down approximation by using experimental energy-distance curves as well as stopping power formulas. Simulation of charge-changing processes is performed by using empirical data and relationships for the electron capture and loss cross sections. The spreading of the beam due to elastic collisions is considered in the framework of the theories of Molière and of Lindhard, Nielsen, and Scharff. The calculations provide the line profile in the focal plane of a separator as a function of apparatus parameters (such as field geometry, gas species and gas density) and particle parameters (mass, nuclear charge, ionic charge and velocity). This study allows the deduction of optimum operational conditions for various applications. Results of calculations are presented and compared with measurements. (auth)

18410 SEPARATION OF ISOTOPES BY ELECTROMIGRATION. Theory of Steady-State Enrichment at the Low Concentration Range. Roy, A. S. (Univ. of the Negev, Beersheva, Israel). J. Electrochem. Soc.; 120: No. 8, 1044-1048(Aug 1973).

The general differential equation for isotope separation by countercurrent electromigration is derived, normalized for the general case independent of properties of any particular liquid system, and solved for steady-state enrichment of an isotope of low abundance. Two primary process parameters are defined, the reduced reflux ratio, ρ, and reduced number of plates, ν, in terms of which the process is specified. The ranges within which the reflux ratio and number of plates may vary are determined. Minimum $\rho\nu$ is established as a criterion for preferred operation and a general solution is derived to comply with this criterion. The general solutions of the differential equations provide easy application of the results for any system of any particular properties. (auth)

Isotopic Power Sources

Refer also to abstracts 18094, 18106–18109, 18113–18122, 18124–18138, 18140–18152, and 18705.

18411 POWER FROM RADIOISOTOPES. Proceedings of the Second International Symposium, Madrid, Spain, May 29, June 1, 1972. Washington, DC; OECD Publications Center (1972). 987p. (In French and English). (CONF-720519-). $24.00.

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972).

Fifty-eight papers were presented. A separate abstract was prepared for each of 53. Five papers were previously abstracted in NSA. For abstracts of these see CONF-720519- in the Report Number Index. (LCL)

For abstracts of individual papers see: 18079–18081, 18106–18152, and 18412–18414.

18412 GENERAL CONSIDERATIONS OF RADIOISOTOPIC POWER AND ITS INTERNATIONAL ASPECTS. Cellini, R. F.; (Junta de Energia Nuclear, Madrid); Stadie, K. B. pp 19-26 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

Background information is presented on: the definition of radioisotopic power; systems for converting the decay energy of radioisotopes to electric power; the economics of radioisotope batteries; and the selection of specific radioisotope heat sources and conversion systems. The work of the OECD Nuclear Energy Agency since 1967 in studying radioisotope batteries, particularly for cardiac pacemakers is discussed. This work included: heat source development; capsule evaluation; safety assessments of radioisotope heat sources under normal and accident conditions; studies of conversion devices, mainly semiconductor thermocouples; radiation hazards evaluations; and, finally, human implantation of ^{238}Pu-fueled pacemakers which began in April 1970. Future work will include the development of radioisotope batteries for other applications such as artificial hearts and communications equipment. The role of the OECD Nuclear Energy Agency in this past and future work is stressed. (LCL)

18413 STATISTICAL METHODS FOR THE DETERMINATION OF ^{238}Pu DEMAND FOR MEDICAL APPLICATION. Specht, S.; Weinlaender, W. (Technische Univ., Munich). pp 171-184 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

A computer program was developed in order to calculate more exact values for the amounts of ^{238}Pu required by radioisotope batteries used for medical purposes. Data concerning the chemical aspects of pacemaker therapy are used in the calculations. Available information is used to estimate the ^{238}Pu requirements (for energy sources) for the German Federal Republic and Western Europe. The program also gives an estimate of the ^{238}Pu requirements for envisaged therapeutic medical applications. (auth)

18414 DESIGN AND FABRICATION OF ^{238}Pu SOURCES. Lins, W. (ALEM, Hanau, Ger.); Weinlaender, W. pp 893-905 of Power from Radioisotopes. Washington, DC; OECD Publications Center (1972).

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972). See CONF-720519-.

A ^{238}Pu device for the Siemens-type thermoelectric converter was developed. The criteria leading to the choice of the fuel form and the cladding materials are discussed, in connection with the safety aspects involved. The different fabrication steps of the capsule are described, beginning with the purification of ^{238}Pu, the primary treatment, the fabrication of the fuel and of the capsule, and the quality control. First results of the safety tests of the device are shown. (auth)

Radiation Sources

Refer also to abstract 20228.

18415 (DP-MS-72-45) CALIFORNIUM-252 NEUTRON SOURCES. Crandall, J. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 1 Sep 1972. Contract AT(07-2)-1. 15p. (CONF-720902-8). Dep. NTIS $3.00.

From national topical meeting on the applications of californium-252; Austin, Texas USA (11 Sep 1972).

Major production programs for the Savannah River reactors and the High Flux Isotopes Reactor at Oak Ridge have made ^{252}Cf one of the most available and, at the USAEC's sales price of $10/$\mu$g, one of the least-expensive isotopic neutron sources. Reactor production has totaled approximately 2 grams, and, based on expected demand, an additional 10 grams will be produced in the next decade. The ~800 mg chemically separated to date has been used to prepare over 600 neutron sources. Most, about 500, have been medical sources containing 1 to 5 μg of ^{252}Cf plated in needles for experimental cancer therapy studies. The remainder have generally been point sources containing 10 μg to 12 mg of oxide for activation, well logging, or radiography uses. Bulk sources have also been supplied to the commercial encapsulators. The latest development has been the production of ^{252}Cf cermet wire which can be cut into almost contamination-free lengths of the desired ^{252}Cf content. Casks are available for transport of sources up to 50 mg. Subcritical assemblies have been developed to multiply the source neutrons by a factor of 10 to 40, and collimators and thermalizers have also been extensively developed to shape the neutron flux and energy distributions for special applications. (auth)

18416 METHOD OF MANIPULATING RADIUM APPLICATORS. Rytilae, A. (Univ. Central Hospital, Helsinki). pp 106-108 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The handling of closed radium applicators for therapy is discussed including transport, washing, sterilization, storage, inventorying, and introduction into the patient. (WHK)

18417 NEUTRON SPECTRA OF ISOTOPIC (α,n) SOURCES. Tyufyakov, N. D.; Trykov, L. A.; Shtan, A. S. At. Energ. (USSR); 34: No. 5, 349-353(May 1973). (In Russian).

The effect of a number of parameters of isotopic (α,n) sources on the form of neutron spectra is examined on the basis of experimental investigations and published data. It is shown that existing divergencies in neutron energy spectra of single-type (α,n) sources are related mainly to the measuring and data handling techniques. (10 figures, 7 references) (auth)

Design and Fabrication

18418 (DP-MS-72-35) LONG-TERM INTEGRITY OF ^{252}Cf SOURCE MATERIALS. McDonell, W. R.; Mosley, W. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 1972. Contract AT(07-2)-1. 12p. (CONF-720902-9). Dep. NTIS $3.00.

From national topical meeting on applications of californium-252; Austin, Texas, USA (11 Sep 1972).

Preliminary evaluations indicate that spalling of inner capsule surfaces injected with helium gas should be the principal mode of deterioration of ^{252}Cf sources at low temperatures, producing no more than about 0.010-in. thinning of the inner capsule over a 10-y source life-time. Additional capsule erosion due to alpha particle, neutron, or fission fragment impact should be minor. No deleterious chemical incompatibility of $^{252}Cf_2O_3$ and the platinum alloy capsule is expected below 1000°C, although some ^{252}Cf may be injected into the capsule wall by self-transfer due to fission fragment impact. Hardening and embrittlement of $^{252}Cf_2O_3$–Pd wire forms that may occur because of internal helium generation may be relieved by annealing. Experimental investigations have been undertaken to measure the thinning of ^{252}Cf capsules by helium gas spalling and fission fragment impact, and to verify chemical compatibility of source and capsule materials. Threshold conditions for hardening and embrittlement of ^{252}Cf– Pd wire forms are being determined. (auth)

18419 YTTERBIUM-169 SOURCES FOR INDUSTRIAL RADIOGRAPHY PRODUCTION AND PRACTICAL USE. Wood, N. R.; Gillespie, P. A. Test., Instrum. Contr.; 10: No. 4, 11-17(Apr 1973).

The radiography of steels less than ½ in. thick and of aluminium less than 2 in. thick using radioisotopes is usually unsatisfactory because the commonly available radioisotopes (iridium-192 and cobalt-60) do not produce radiographs of sufficient sensitivity, and the only other suitable source, thulium-170, has low specific activity and requires long exposure times. Ytterbium-169 is advanced as a practical radiographic source for these thicknesses despite its short half-life (31 days). The principal gamma ray emissions of ytterbium-169 are 53 keV and 63 keV. The intensity of these gamma rays produced by a typical radiographic source of 10 curies is equivalent to that produced by 150 curies of thulium-170. Industrial ytterbium radiographic sources produced in Australia are described and the necessary information is given for the production of radiographs of optimum density and sensitivity. (auth)

18420 POST-IRRADIATION ENHANCEMENT OF LETHALITY BY N-ETHYLMALEIMIDE IN YEAST CELLS. Cercek, L.; Averbeck, D.; Cercek, B. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol.; 46: No. 547, 562-564(Jul 1973).

Experiments are described, which demonstrated that in log-phase yeast cells n-ethylmaleimide (NEM) decreases survival more if administered after hypoxic irradiation than if present during irradiation. This is in contrast to earlier reported work. It is shown that for equal doses of radiation and equal times of treatment with NEM, the survival is reduced more by 8×10^{-5} M if added 15 sec after than if it is present during the irradiation. A characteristic initial dip in the post-irradiation enhancement of lethality is demonstrated, which is thought to be a characteristic feature of the time dependence of lethality enhancement by NEM. (UK)

18421 PLANNING OF RADIUM APPLICATORS. Vayrynen, T.; Rytilae, A. (Univ. Central Hospital, Helsinki). pp 103-105 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The design of steel-encapsulated radium applicators for use in gynecological radiotherapy is discussed. (WHK)

Industrial Uses

Refer also to abstracts 18156, 18160, 18444–18450, 18458, 19867, 19902, and 20357.

18422 LIGHTNING CONDUCTOR. Constant, R. (to Centre d'Etude de l'Energie Nucleaire). Belgian Patent 748,226. 31 Mar 1970. (In French).

A lightning conductor consisting of a rod at the pointed extremity and a chemically inert gaseous source and sensitive to beta radiation characterized by the fact that the source is located in immediate proximity to the rod is described. (TSS)

18423 GRAIN IRRADIATOR BEING DEVELOPED IN JAPAN. Hoshi, T. (Japan Atomic Energy Research Inst., Takasaki, Japan). Shokuhin Shosha; 5: No. 2, 19-20(Mar 1971). (In Japanese).

A 0.6 ton/hr silo type irradiation test plant entered into test operation in May, 1971, after 2 years of developmental work (supported specifically by the government) at JAERI Takasaki Laboratory. The radiation source is a 4,000 Ci ^{60}Co rod with a maximum dose of 2.0×10^4 rad and a uniformity of 2.0. An outline of the plant, features in design philosophy, and methods of operation are briefly described. (JA)

18424 GAMMA IRRADIATION FACILITIES FOR THE FOOD INDUSTRY. Kasamatsu, T. (Japan Atomic Energy Research Inst., Tokai). Shokuhin Shosha; 5: No. 2, 21-25(Mar 1971). (In Japanese).

Institutions for food irradiation should be established with due regard to many conditions. In case of γ-ray irradiation, especially, many problems remained unsolved. One thing to be considered is whether foods to be irradiated are in solid, granular, or liquid state and whether or not the articles to be irradiated are in boxes. Fruits and potatoes are irradiated without being put in boxes. When they are irradiated in boxes, size and material of the boxes change irradiating conditions. The conditions for total dose and dose rate by which the irradiation becomes effective is most important. The optimum conditions for the dose should be decided according to each irradiating purpose, as sufficient effect cannot be obtained if the dose is less than a certain limit, or undesirable effects are produced when the dose is more than the limit. At present, studies of the relation between production and cost is no better than trial and error. As for its utilization, irradiation cost becomes the serious problem and automatic machine operation is desirable because of its safety. Practical cases of irradiation of liquids and solids are described in detail. (JA)

18425 IMPROVEMENTS RELATING TO METHODS OF PRODUCING FILMS COMPRISING SILICEOUS MATERIAL. Martin, B. F.; Roberts, E. D. (to Mullard Ltd.). British Patent 1,316,711. 16 May 1973. Filed date 15 Mar 1971. 6p.

A method is described for producing an apertured siliceous film on a substrate. If the substrate is a semiconducting material such a film may be used as a diffusion mask in the manufacture of a semiconductor device, or as a passivating layer on such a device. A polysiloxane layer is applied to the substrate and the layer is irradiated in accordance with a predetermined pattern with an electron beam of sufficient energy to penetrate through the layer to the substrate. The layer is then etched until apertures are made in accordance with the selected pattern, followed by heating the etched layer so as to decompose the organic material and leave the apertured siliceous film on the substrate. The applied layer may consist of a mixture of polymethyl methacrylate and polysiloxanes, and the charge density used for irradiation may be 50 to 500 $\mu C/cm^2$. The etching agent may be HF solution. Examples are given. (UK)

18426 POSITION INDICATING SYSTEM AND METHOD THEREFOR. Kaminskas, R. (to United States Atomic Energy Commission). U. S. Patent 3,736,430. 29 May 1973. Filed date 23 Oct 1969. 12p.

An aircraft landing system based upon two or more beams of nuclear radiation is described. Each beam is shaped to conform to a desired pattern and is frequency modulated for identification and comparison purposes. Overlapping of two beams provides a spatial plane to serve as one reference such as a glide slope. A second pair of overlapping beams aligned substantially perpendicular to the first reference provides a second spatial plane to serve as a second reference such as a localizer beam. Appropriate circuitry aboard approaching aircraft is provided to determine the position of the aircraft with respect to the two reference beams. (Official Gazette)

LIFE SCIENCES

Radiation Effects on Biochemicals

Refer also to abstracts 17982, 18485, and 20663.

18427 (AEC-tr-7430, pp 121-125) STUDY OF THE CHANGES IN THE STRUCTURE OF IRRADIATED PHOSPHOFRUCTOKINASE. Ermekova, V. M.; Postnikova, G. B.; Artyukh, R. I.; Marinov, V. S.; Kayushin, L. P. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 13: No. 1, 91-94(1973).

The changes in the structure of phosphofructokinase under the action of radiation were studied by the method of stable specific paramagnetic labels. It was shown that when the enzyme in a concentration of 300 μg/ml is irradiated at a dose of 3 to 5 kR, there is an inhibition of the mobility of the protein-bound label; beginning with a dose of 10 kR, a gradual decrease in the mobility of bound radicals is noted, which is evidence of certain conformational rearrangements in the region of attachment of the label. When phosphofructokinase in a concentration of 100 μg/ml is irradiated, the corresponding changes are detected at lower doses. The possible role of structural changes in irradiated phosphofructokinase in the disruption of the allosteric function of the enzyme is discussed. (tr-auth)

18428 (AEC-tr-7430, pp 126-130) INFLUENCE OF IRRADIATED LECITHIN ON THE SURVIVAL AND REDOX POTENTIAL OF MOUSE MUSCLE TISSUE. Goida, E. A.; Tymochko, M. F. (Inst. of Biochemistry, Lvov). Translated from Radiobiologiya; 13: No. 1, 95-98(1973).

Results obtained show that intraperitoneal injection of irradiated lecithin into mice leads to death of the animals, and its toxicity depends on the dose of irradiation. Irradiated lecithin promotes a decrease in the redox potential of muscle tissue by an average of 30 mV 10 to 15 min after its introduction into the organism. (tr-auth)

18429 (RLO-2225-T-15-16) FORMATION OF PHOTOREVERSIBLE CYCLOBUTANE-TYPE PYRIMIDINE DIMERS IN ULTRAVIOLET IRRADIATED POTATO VIRUS X. Huang, C. W.; Gordon, M. P. (Washington Univ., Seattle (USA). Dept. of Biochemistry). 1972. Contract AT(45-1)-2225. 18p. Dep. NTIS $3.00.

Photoreversible cyclobutane-type pyrimidine dimers were found in ^{32}P-labeled RNA isolated from intact potato virus X irradiated with 254 nm light. The number of dimers was correlated with the biological infectivity of the ultraviolet-treated virus. Assuming that incorporated ^{32}P is homogeneously distributed in the viral RNA chain, it can be calculated that about 5.7 ± 1.7 dimers are present in each strand of virus per lethal biological hit. (auth)

18430 γ-RAY-INDUCED CHAIN BREAKS AND ALKALI-LABILE BONDS IN λdv DNA OF ESCHERICHIA COLI MINICELLS IRRADIATED UNDER AEROBIC AND ANOXIC CONDITIONS. Paterson, M. C.; Roozen, K. J.; Setlow, R. B. (Univ. of Tennessee, Oak Ridge). Int. J. Radiat. Biol.; 23: No. 5, 495-508(May 1973).

Chromosomeless minicells were formed by misplaced cell fissions near the polar extremities of an Escherichia coli K12 mutant strain. Superhelical λdv DNA could be introduced into minicells by segregation from a λdv-containing derivative of the original mutant. One single-strand break changed the sedimentation constant of such a DNA and hence sedimentation of minicell lysates in neutral and alkaline sucrose gradients enabled accurate counting of the numbers of "clean" chain breaks and alkali-labile bonds produced in DNA by γ irradiation in vivo. Although the total number of single-strand breaks measured in alkali was enhanced three- to fourfold when ^{60}Co γ rays were delivered to an oxygenated minicell suspension, the fraction that required an alkaline environment for expression was almost twice as great in minicell samples irradiated in the absence (~35%) as in the presence (~21%) of oxygen. In contrast to chain breaks, alkali-labile bonds did not disappear from DNA of minicells during post-radiation incubation and, therefore, are presumed unsuitable substrates for certain DNA repair enzymes operative in minicells. (auth)

18431 INACTIVATION OF TMV-RNA BY ULTRA-VIOLET RADIATION IN SUNLIGHT. Murphy, T. M. (Univ. of California, Davis). Int. J. Radiat. Biol.; 23: No. 5, 519-526(May 1973).

The ultraviolet component of sunlight inactivated the infectivity of purified tobacco mosaic virus RNA. The rate of inactivation in summer was high enough to suggest that ultraviolet radiation from sunlight may damage a significant proportion of certain kinds of RNA molecules in exposed plant tissues. The sunlight-inactivated TMV-RNA could be photoreactivated in tobacco leaves. (auth)

18432 NUCLEIC ACID METABOLISM IN X-IRRADIATED RAT THYMOCYTES. Geraci, J. P. Seattle; Univ. of Washington (1972). 89p. University Microfilms Order No. 73-13,823. Thesis (Ph. D.).

The role of nucleic acid metabolism in radioinduced interphase death of in vitro x-radiated thymocytes was studied. Cells were examined for early radio-induced alterations in base phosphorylation, incorporation of labeled substrate into nucleic acid and protein, and post-transcriptional metabolism of RNA labeled prior to exposure. A significant enhancement of incorporation of thymidine into DNA of x-radiated thymocytes, pulse labeled immediately after exposure, was observed. Experiments utilizing hydroxyurea suggest that this stimulated incorporation of thymidine is associated with normal semiconservative processes and not to a restitution process. Depression in the incorporation of labeled uridine and thymidine into RNA and DNA was detectable within one hour after exposure and this occurs prior to inhibition of L-leucine incorporation, base phosphorylation, or RNA methylation. These data suggest that alterations in protein synthesis, base phosphorylation, and RNA methylation are secondary to alteration in nucleic acid metabolism. Radio-induced catabolism of prelabeled RNA was observed within 30 minutes after exposure. The magnitude of loss of label from RNA was related to the time interval between pulse labeling and subsequent x-ray exposure. Newly synthesized RNA (labeled 30 minutes before exposure) is sensitive to radio-induced loss of activity while RNA labeled 4.5 hours before exposure is very much less sensitive. Further experiments characterize the radio-induced depolymerization of RNA, reveal that it requires active protein synthesis, is specific for nonmethylated RNA, occurs in the nucleus, and is partially due to acceleration of the non-conservative maturation of ribosomal RNA in irradiated thymocytes. (Diss. Abstr.)

18433 STUDY OF EFFECTS OF CYCLIC AMP AND RELATED DRUGS ON X-RADIATION-INDUCED DEPRESSION OF DNA SYNTHESIS AND MITOSIS IN MOUSE S-180 ASCITES TUMOR CELLS. Boynton, A. L. Iowa City, IA; Univ. of Iowa (1972). 206p. University Microfilms Order No. 73-13,503. Thesis (Ph. D.).

Cells in log phase growth were irradiated in vivo and effects on DNA synthesis were studied by using pulse labeling with tritiated thymidine (^{3}HTdR). Thirty minutes after administration of the ^{3}HTdR, the cells were removed from the abdominal cavity. Some of the cells were used for autoradiographs in order to determine the labeling index. Aliquots from the same sample were used for liquid scintillation counting to determine the radioactivity per mg wet weight of cells. These data combined with the number of labeled cells permitted the calculation of the amount of tritium per labeled cell. Samples of tumor cells were also removed and stained with acetocarmine to enable the determination of the mitotic index at different times after the irradiation. X-irradiation (500 R) depressed the synthesis of DNA. Adding cyclic AMP had no effect on DNA synthesis of unirradiated cells. Also it had no effect on DNA synthesis of irradiated cells. Dibutyryl cyclic AMP depressed DNA synthesis of unirradiated cells but had no further action on irradiated cells in which DNA synthesis had been reduced. Caffeine, 1.0 ml 10^{-3} M, injected I.P. 10 minutes before x-irradiation greatly reduced the magnitude of the radiation-induced depression of DNA synthesis. Other drugs which theoretically would raise endogenous levels of cyclic AMP (theophylline and isoproterenol) were ineffective. Following an exposure of 200 R, the mitotic index of the tumor cells dropped to a minimum within an hour and remained low for a period of about 5.0 hours and had not returned to control levels by the end of the experimental period (7.0 hours). The addition of caffeine before irradiation shortened the period of mitotic inactivity and enhanced the recovery so that near the end of the period of observation (7.0 hours) the mitotic index was much higher than that of the unirradiated cells. This effect of caffeine was not seen when the injection was made 20 minutes before x-irradiation and it was not evident when the caffeine was administered immediately after x-irradiation. The radiation-induced depression of mitosis was also reduced by prior injection of theophylline and dibutyryl cyclic AMP. Cyclic AMP and isoproterenol did not alter the radiation-induced inhibition of mitosis. (Diss. Abstr.)

18434 INFLUENCE OF MOLYBDENUM AND COBALT ON THE NITROGENOUS EXCHANGE OF COTTON TREATED WITH GAMMA RAYS (γ RAYS). Mukhtarova, L. S.; Guseinov, S. G.

Dokl. Akad. Nauk Azerb. SSR; 28: No. 9-10, 62-65(1972). (In Russian).

The results of research of the nitrogenous exchange showed that under the effect of gamma rays in corresponding doses the synthesis and accumulation of nitrogenous elements increase especially in protein in the plant. Microelements cobalt and molybdenum exhibit a specific influence on the nitrogenous exchange in plants. (auth)

Radiation Effects on Cells

Refer also to abstracts 17981, 18432, 18455, and 18466.

18435 (AD-757660) EFFECT OF IONIZING RADIATION UPON MITOCHONDRIA OF THE CENTRAL NERVOUS SYSTEM. Cohan, S. L.; Abbott, J. R.; Catravas, G. N. (Armed Forces Radiobiology Research Inst., Bethesda, MD). Oct 1972. 18p. (AFRRI-SR-72-17). NTIS.

The respiratory rate in the presence of substrate + ADP (state 3) and after the conversion ADP yields ATP (state 4) was studied in mitochondria of the rat brain after irradiation of the rats' heads with an electron linear accelerator. After 20,000 rads irradiation there was a transient diminution of respiratory control (state 3/state 4) when glutamate was used as the substrate, but no abnormalities were seen when succinate was the substrate. Irradiation with 10,000 rads had no effect on the respiratory rate or respiratory control. The addition of DPNH to irradiated mitochondria had no effect on mitochondrial respiration as compared to controls. Irradiation of the brain with 20,000 rads failed to produce significantly greater peroxidation than in sham irradiated mitochondria and failed to produce greater swelling in irradiated mitochondria, even in the presence of $FeNH_4SO_4$ or ascorbate. The slight and transient changes in respiratory control produced by irradiation in brain mitochondria are in marked contrast to the susceptibility of mitochondria from other organs. The comparative radioresistance of brain mitochondria may be the result of greatly diminished radioinduced peroxidation of mitochondrial membranes. (auth)

18436 IMMUNOLOGICAL DEMONSTRATION OF THE DISAPPEARANCE OF PYRIMIDINE DIMERS FROM NUCLEI OF CULTURED HUMAN CELLS. Lucas, C. J. (Univ., Amsterdam). Exp. Cell Res.; 74: 480-486(Oct 1972).

Antisera were prepared containing antibodies, reacting only against ultraviolet light (UV)-irradiated DNA. The antibodies were specific for thymine dimers, and they were used to indicate the disappearance of detectable dimers from nuclear DNA. Following an UV dose of 300 erg/mm^2 all detectable dimers were removed within 4 h from the nuclei of human amnion cells grown in vitro. (auth)

18437 EXTREME RADIOSENSITIVITY IN MURINE LEUKEMIC LYMPHOBLASTS: EXPRESSION AT THE MOLECULAR AND CYTOLOGICAL LEVELS. Ehmann, U. K. Fort Collins, CO; Colorado State Univ. (1972). 66p. University Microfilms Order No. 73-13,029.

Thesis (Ph. D.).

A detailed analysis of the mode of death was made using time-lapse photography and fluorometric techniques. Mitotic delay was much longer than that reported for other mammalian cells, amounting to at least 8 hours at a dose of 100 rads. During this time cell volume spectra indicated a size change of almost a factor of 2. Fluorometry with acriflavine stained cells showed the cells traversing the G_1 and S phases of the cycle with little or no delay and accumulating in G_2 before any cell division is evident. Most of these first divisions appeared abnormal, multipolar divisions and fusions being observed frequently on time lapse films, and very few cells experiencing more than 6 or 7 total divisions of it and its progeny before death of the colony, even at relatively low doses, such as 100 rads. Survivors were among the first cells in the asynchronous populations to divide after irradiation suggesting that they come from a particular phase of the cell cycle. Taken altogether, the low D_0, the long mitotic delay, the cell volume increase, and frequency of abnormal division, describe the most x-ray sensitive mammalian cell known. (Diss. Abstr.)

18438 RADIOSENSITIVITY, RNA, AND PROTEIN METABOLISM OF LEAKY AND ARRESTED CELLS IN SUNFLOWER ROOT MERISTEMS (HELIANTHUS-ANNUUS). Rost, T. L.; Van't Hof, J. (Brookhaven National Lab., Upton, NY). Amer. J. Bot.; 60: No. 2, 172-181(1973).

Two cell populations in sunflower root meristems are described. Most cells stop in G1 after being cultured in sucrose-deficient medium, but "leaky" cells continue through DNA synthesis and stop in G2. A comparison of leaky and arrested cells is reported on the basis of radiosensitivity, and cytological and biochemical responses to metabolic inhibitors. Leaky cells are randomly distributed throughout primary meristematic tissues. They are not inhibited from initiating DNA synthesis by exposure to doses of γ radiation ranging from 300 to 7200 R; arrested cells, depending upon the dose, are inhibited partially or completely. Leaky cells do, however, show a dose-dependent mitotic delay in G2, which is the same as arrested cells. Treatment with puromycin and actidione does not inhibit leaky cells from initiating DNA synthesis but does inhibit them from mitosis. Arrested cells are inhibited from advancing to S and M by both inhibitors. Also, puromycin and actidione cause a decrease in protein and RNA synthesis, demonstrating a possible protein dependent RNA synthesis necessary for cell cycle progression. Actinomycin D (10 μg/ml) inhibits neither leaky nor arrested cells from entering S and M. At 30 μg/ml, however, arrested cells are partially inhibited. Leaky cell metabolism is unique in preparation for and initiation of DNA synthesis but similar to that of the remaining cells of the meristem in terms of requirements for progression through the rest of the mitotic cycle. (auth)

18439 NEUTRON SPECTRUM DEPENDENCE OF RBE AND OER VALUES. Railton, R.; Lawson, R. C.; Porter, D.; Hannan, W. J. (Western Regional Hospital Board, Glasgow). Int. J. Radiat. Biol.; 23: No. 5, 509-518(May 1973).

The loss of reproductive capacity of Chinese hamster cells grown in vitro was investigated using ^{60}Co γ rays and two neutron beams of different quality. Survival curves were determined for aerobic and hypoxic cells. Relative to ^{60}Co γ rays, the RBE values at the 10% cell-survival level were 2.50 ± 0.12 for 14.7-MeV neutrons and 3.02 ± 0.20 for a degraded spectrum produced by transmitting these neutrons through a block of uranium. The corresponding OER values were 1.56 ± 0.11 and 1.66 ± 0.22. The implications of these results are discussed with reference to neutron therapy. (auth)

18440 ADAPTATION OF PLAQUE ASSAY METHODS TO THE IN VITRO QUANTITATION OF THE RADIATION LEUKEMIA VIRUS. Niwa, O.; Decleve, A.; Lieberman, M.; Kaplan, H. S. (Stanford Univ., CA). J. Virol.; 12: No. 1, 68-73(Jul 1973).

A modification of the XC cell procedure for murine leukemia virus assay, which yields quantitative data over a wide range of virus concentrations, is described. By using serial passage of infected cell cultures and reversal of the plating sequence in the XC procedure, titers of radiation leukemia virus (RadLV) were obtained which were about 10-fold higher than those found by using the conventional assay. By using the modified procedure, it was observed that, even at high multiplicities of infection, less than 10% of the cells function as infective centers, although the proportion increases with serial passage. It was also observed that exposure of infected cells to uv light, which is commonly used to make plaques more visible in the conventional XC cell test, inhibits plaque formation in the RadLV system. Substitution of x irradiation for uv exposure improved plaque visibility without loss of sensitivity. (auth)

18441 INDUCTION OF TYPE C VIRUSES IN CULTURED GUINEA PIG CELLS. Nayak, D. P.; Murray, P. R. (Univ. of California, Los Angeles). J. Virol.; 12: No. 1, 177-187(Jul 1973).

Particles morphologically resembling type C viruses were activated by bromodeoxyuridine (BUdR; 10^{-4} M) treatment of cultured guinea pig cells. Virus particles were isolated from the cells of normal and leukemic strain 2 and random-bred guinea pigs (adult and embryonic). Immature virus particles with electron-lucent cores were found in the cytoplasmic matrix. The mature particles with electron-dense cores were found outside the cells and some appeared in the process of budding from the plasma membrane. The peak of virus production was observed within 4 days of BudR treatment. When compared to the amount of virus produced in darkness, visible light enhanced virus production, whereas exposure of BudR-treated cells to uv light either had no effect or inhibited virus production. Virus particles had a density of 1.16 gm/ml, possessed an oncornavirus-specific reverse transcriptase, and contained a large-molecular-weight RNA (65-70S) which dissociated into 36S subunits after heat denaturation. The BUdR-activated virus particles, therefore, possessed the morphological, biophysical, and biochemical characteristics of type C oncornaviruses. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 18430, 18440, and 18441.

18442 (AEC-tr-7430, pp 136-140) INVESTIGATION OF THE ROLE OF THIOLS IN THE MODIFICATION OF THE RADIOSENSITIVITY OF CHLORELLA DURING THE CELL CYCLE. Apasheva, L. M.; Gusareva, E. V.; Kulinich, A. V.; Pyatyshev, D. R.;

Shevchenko, V. A. (Inst. of Developmental Biology, Moscow). Translated from Radiobiologiya; 13: No. 1, 102-105(1973).

The relationship between the radiosensitivity that varies during the cellular cycle, and the corresponding fluctuations in the level of total thiols in the cells was investigated on a synchronous culture of cells of three strains of Chlorella vulgaris Beijer (LARG-1, 260, 285). A direct correlation was detected between these indices, permitting the conclusion that endogenous thiols, which play the role of a natural protector, are capable of determining the radiosensitivity of cells to a substantial degree. (tr-auth)

18443 (AEC-tr-7430, pp 206-211) MECHANISM OF THE INHIBITION OF REPRODUCTION OF TOBACCO MOSAIC VIRUS IN TOBACCO LEAVES SUBJECTED TO X IRRADIATION. Pod'yapol'skaya, T. S. (Inst. of General Genetics, Moscow). Translated from Radiobiologiya; 13: No. 1, 149-152(1973).

The irradiation of leaves in a moderate dose (15 kR) before and after their infection with tobacco mosaic virus (TMV) does not influence the infectiousness of the virus RNA, unprotected by structural protein. The basic factor determining the inhibition of virus reproduction in irradiated tissues is the inhibition of new formation of virus RNA. A transitory influence of radiation on the synthesis of structural protein of TMV can be detected under special experimental conditions. (tr-auth)

18444 (AEC-tr-7437) STUDY OF POSSIBILITIES OF USING IRRADIATION TO DECONTAMINATE SPICES. van Dijk, L. G. M. (ed.) 1970. Translation of Etude des Possibilites d'Application de l'Irradiation a la Decontamination des Epices. 68p. Dep. NTIS $5.50.

The feasibility of using ionizing radiation for the sterilization of microorganisms contaminating spices was investigated. Samples of ground white pepper, red pepper, nutmeg, mace, cloves, cardamom, and dried onion powder were exposed to doses of γ radiation of 0.5 or 0.8 Mrad. A great reduction in the number of microorganisms was observed following irradiation. The effects of packaging in vacuum on the keeping qualities of the spices were also studied. No difference in the taste or odor of foods flavored with irradiated spices was detected, except a slight difference in the taste of foods flavored with a mixture of spices. (CH)

18445 (COO-1689-8) RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY. Annual report, June 15, 1971–June 15, 1972. Urbain, W. M. (Michigan State Univ., East Lansing. Dept. of Food Science and Human Nutrition). Jun 1972. Contract AT(11-1)-1689. 182p. Dep. NTIS $11.25.

Separate abstracts were prepared for four sections of this report. (CH)

For abstracts of individual sections see: 18446–18449.

18446 (COO-1689-8, pp vp Paper 1) RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY. Quarterly Report, June 15, 1971–September 15, 1971. Urbain, W. M.; Wang, S. L. Jun 1972.

In radiation pasteurization of fresh meats and poultry. Annual report, 1971–1972.

The effects of treatment of γ-irradiated beef with different Na salts of phosphate on color and other organoleptic properties following vacuum storage at 38°F were investigated. Because of its greater solubility, a sodium metaphosphate glass (SMPG) (64% P_2O_5) was investigated for its effects on color. High concentrations (30%) yielded sufficient phosphate uptake by large-cuts with dipping alone. Preliminary results, however, indicate the metaphosphate glass was not effective in maintaining color. (CH)

18447 (COO-1689-8, pp vp Paper 2) RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY. Quarterly Report, September 16, 1971–December 15, 1971. Urbain, W. M.; Wang, S. L. Jun 1972.

In radiation pasteurization of fresh meats and poultry. Annual report, 1971–1972.

The effects of treatment of γ-irradiated beef with different Na salts of phosphate on color and other organoleptic properties following vacuum storage at 38°F were investigated. Kena (64% P_2O_5 sodium metaphosphate glass) was studied using beef rounds of one-day and ten-day post mortem age. The beef rounds were treated with Kena solution, vacuum-packaged, irradiated to a dose of 100 krad and stored at 38°F for 18 days. The color appearance after exposure to air was dull red, and drip loss was higher in the one-day post mortem round than in the ten-day post mortem round. For both post mortem ages a non-spoilage odor developed after storage. The microbial populations were within the normal range. (CH)

18448 (COO-1689-8, pp vp Paper 3) RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY. Quarterly Report, December 16, 1971–March 15, 1972. Urbain, W. M.; Wang, S. L. Jun 1972.

In radiation pasteurization of fresh meats and poultry. Annual report, 1971–1972.

Work was continued on the treatment of large cuts of γ-irradiated beef by means of dipping and pumping. The principal phosphate employed for these treatments was sodium tripolyphosphate. With the use of a nearly saturated sodium tripolyphosphate solution, 13 to 14% (w/w), the treated and stored large beef cuts maintained acceptable surface color inside the O_2-permeable film for 2 to 4 days. The favorable effect of drip control by TPP treatment was not found with the one-day post mortem beef. The eating quality of the treated beef was distinguished from the fresh reference samples by the taste panel, but was not objectionable to the panel. The intensity of flavor changes of beef irradiated at a dose of 200 krad at different dose rates, storage time, and temperature of irradiation were also investigated. No significant difference due to dose rate or storage time was found. (CH)

18449 (COO-1689-8, pp vp Paper 4) RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY. Quarterly Report, March 16, 1972–June 15, 1972. Urbain, W. M.; Wang, S. L.; Groesbeck, C. P. Jun 1972.

In radiation pasteurization of fresh meats and poultry. Annual report, 1971–1972.

Large pieces of beef were pumped with 13% Na tripolyphosphate (TPP) and the surface covered with 13% (TPP) by dipping or spraying. After being held for a period of TPP diffusion, the large piece was cut into smaller portions, vacuum-packaged, γ irradiated and stored at 38°F for 18 days. The TPP-treated samples in general had lower drip losses than non-phosphated samples, and drip losses were lower from large cuts than from slices. Eating quality of the TPP-treated samples was poorer than that of the fresh reference samples, particularly in texture, juiciness, and overall quality. Among the treated and stored samples, no significant difference was found although the large cuts were rated higher than the slices. Lamb, pork, and chicken were successfully treated with 13% TPP dip. Color appearance of the treated samples was very satisfactory and the drip losses were markedly reduced by TPP-treatment. Eating qualities of lamb, pork and chicken after 18 days vacuum storage and 3 days air storage were scored by the taste panel favorably. The panel scores showed that texture of these commodities, unlike beef, was not affected by TPP-treatment and storage. However, occasional off-odor was detected from the treated samples. It was suggested that careful handling was required to reduce the initial microbial counts. The results of the microbiological studies showed that after irradiation the microbial counts were reduced by one to two log cycle. Microbial spoilage of the irradiated beef would ultimately occur. No evidence of new health hazard as a consequence of the irradiation procedure was found. (CH)

18450 (COO-1689-9) RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY. Annual Report, June 16, 1972–June 30, 1973. Urbain, W. M. (Michigan State Univ., East Lansing. Dept of Food Science and Human Nutrition). Jun 1973. Contract AT(11-1)-1689. 45p. Dep. NTIS $4.25.

Methods for the radiation pasteurization of fresh meats and poultry to permit centralized cutting and packaging of these products were investigated. Data are reported on color changes in beef slices weighing from 200 to 300 gm, dipped in solutions of ascorbic acid or sodium tripolyphosphate, wrapped in oxygen-permeable or oxygen-impermeable plastic film with the packages sealed in vacuum, air, or pure oxygen and irradiated at a total dose of 200 Krad γ radiation delivered at dose rates ranging from 0.05 to 64.0 Krad/sec. The least amount of color change was observed in beef irradiated at low dose rates in the absence of oxygen. (CH)

18451 USE OF UV IRRADIATION IN IMPROVEMENT OF ENZYME PRODUCTION BY BACILLUS SUBTILIS. Suihko, M. L. (Technical Research Center of Finland, Helsinki). pp 151-153 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The effects of uv irradiation on enzyme production by Bacillus subtilis were studied. Mutants isolated from irradiated cultures (2 min exposures) were tested for proteolytic activity, α-amylase, and β-glucanase. The mutation frequency for proteolytic activity was 1 : 200 and for α-amylase 1 : 50. No positive β-glucanase mutants were found under the conditions described. (ERB)

18452 EFFECTS OF ACTINOMYCIN D AND ULTRAVIOLET AND IONIZING RADIATION ON PICHINDE VIRUS. Carter, M. F.; Murphy, F. A.; Brunschwig, J. P.; Noonan, C.; Rawls, W. E. (Baylor Coll., Houston, TX). J. Virol.; 12: No. 1, 33-38 (Jul 1973).

Actinomycin D (0.05 μg/ml) suppresses the synthesis of ribo-

somal RNA of baby hamster kidney (BHK21) cells. The production of infectious Pichinde virus was enhanced in the presence of actinomycin D, although the production of virus particles was not substantially different from cultures inoculated in the absence of the drug. By prelabeling BHK21 cells with ^{3}H-uridine and then allowing the virus to replicate in the presence of actinomycin D, it was possible to show that ribosomal RNA synthesized prior to infection was incorporated into the virion. A single-hit kinetics of inactivation of Pichinde virus was observed with ultraviolet light, suggesting that the virus contains only a single copy of genome per virion. Comparison of the inactivation kinetics by gamma irradiation of Pichinde virus with Sindbis and rubella virus indicated that the radiosensitive genome of Pichinde virus was about 6×10^6 to 8×10^6 daltons. This value is greater than the 3.2×10^6 daltons estimated by biochemical analysis. One possible explanation considered is that the ribosomal RNA of host cell origin is functional and accounts for the differences in genome size estimated by the two methods. (auth)

18453 DNA REPLICATION OF INDUCED PROPHAGE IN HAEMOPHILUS INFLUENZAE. Barnhart, B. J.; Cox, S. H. (Los Alamos Scientific Lab., NM). J. Virol.; 12: No. 1, 165-176 (Jul 1973).

DNA synthesis during transition from the lysogenic state to the lytic cycle and throughout the latter has been studied in Haemophilus influenzae BC200 (HP1c1). Following exposure to ultraviolet light, there is a 30-min delay in DNA synthesis after which there is a rapidly increasing rate of phage DNA synthesis. The phage genome is replicated without extensive utilization of segments or of breakdown products of the bacterial chromosome. The mode of phage DNA replication was investigated by zonal sedimentation of labelled DNA in 5 to 20% neutral and alkaline sucrose gradients. Tritiated thymidine, incorporated during a 2-min pulse given at 38 min, chases rapidly into DNA, sedimenting like linear DNA of approximately 2×10^8 daltons, and then, at the expense of label in this peak, chases into slower-sedimenting phage DNA (2×10^7 daltons). The fast-sedimenting, rapidly labelled DNA satisfies certain criteria for being a concatenated replicative intermediate. Observations in the electron microscope revealed linear concatemers in the faster-sedimenting material and circular phage-sized DNA in the slower-sedimenting DNA. When induced cells are gently lysed with lysozyme and Brij 58 to maintain DNA-membrane associations and sedimented in neutral sucrose over a cesium chloride shelf, the concatemer is found with the cell-membrane-wall complex. Membrane-associated label chases to membrane-free material sedimenting like deproteinized HP1c1 DNA. When membrane-associated DNA from the cesium chloride shelf is deproteinized and resedimented in neutral sucrose, the sedimentation profile reveals that sedimentation rates of labeled DNA from this complex are indicative of sizes ranging from 2×10^8 daltons down to phage-sized pieces of 2 to 3×10^7 daltons. A model is presented that places HP1c1-DNA replication on the cell membrane where a concatemer of phage DNA is synthesized and subsequently degraded to phage-equivalent DNA. Phage-equivalent DNA is then either released from the membrane for packaging or is packaged while still membrane associated. Thus, the cell membrane is not only the site of DNA replication during which phage DNA is synthesized in multiple phage-equivalent concatemers but it is also the site at which these concatemers are selectively reduced to phage-sized pieces. (auth)

Radiation Effects on Plants

Refer also to abstracts 18443, 18484, and 20605.

18454 (AEC-tr-7430, pp 107-111) EFFECTS OF 50 MeV ELECTRONS ON DORMANT SEEDS OF PISUM SATIVUM. Avakyan, T. M.; Asaturyan, R. A.; Oganesyan, D. O.; Adzhyan, N. S.; Kochinyan, E. A.; Stepanyan, L. G. (Erevan Physics Inst.). Translated from Radiobiologiya; 13: No. 1, 80-83(1973).

The effects of high-energy electrons (50 MeV) and x rays (248 keV) on dormant seeds of Pisum sativum were studied. The data obtained show comparative changes in the free radical states, DNA, RNA, protein SH groups, chromosome aberrations, and mitotic activity in the case of these types of radiations. (tr-auth)

18455 (AEC-tr-7430, pp 185-189) EFFECTS OF GROWTH INHIBITORS OF VICIA FABA ON THE SURVIVAL OF EHRLICH'S ASCITES CARCINOMA CELLS IN VITRO. Medvedev, A. I.; Yukova, G. S.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 13: No. 1, 135-138(1973).

The effects of various fractions of extracts isolated from nonirradiated leaves of Vicia faba and leaves irradiated at a dose of 20 kR on the survival of Ehrlich's ascites carcinoma cells in vitro were investigated. A fraction capable of damaging ascites cells in a definite concentration was isolated from the extracts by the method of paper electrophoresis. It was shown that the fraction isolated from irradiated leaves exhibits a stronger injurious effect. The joint action of two substances contained in the isolated fraction is necessary for the manifestation of the effect. (tr-auth)

18456 (AEC-tr-7430, pp 194-200) MECHANISM OF THE STORAGE EFFECT IN IRRADIATED PLANT SEEDS. Gudkov, I. N. (Inst. of Plant Physiology, Kiev). Translated from Radiobiologiya; 13: No. 1, 140-145(1973).

Storage of γ-irradiated seeds for 2 yrs under normal conditions led to a substantial intensification of the radiation damage, the so-called storage effect. Storage of seeds at the temperature 3°C, 5% humidity, and under vacuum weakened this effect. Intensification of the action of radiation during prolonged postradiation storage of seeds is explained by an acceleration of the aging processes during irradiation. The weakening of the storage effect at reduced temperature and humidity, as well as under vacuum conditions, is associated with an inhibition of the oxidative processes accompanying aging. (tr-auth)

18457 (AEC-tr-7430, pp 201-205) INFLUENCE OF GAMMA IRRADIATION OF SEEDS ON THE ULTRAWEAK CHEMILUMINESCENCE AND ANTIOXIDANT ACTIVITY OF WHEAT, CORN, AND BUCKWHEAT SEEDLINGS. Gorlanov, N. A.; Kokorev, Yu. M. (Gorky State Univ., USSR). Translated from Radiobiologiya; 13: No. 1, 145-148(1973).

The dose curves of the dependence of the ultraweak chemiluminescence (UCL), antioxidant activity (AOA), and weight of wheat, corn, and buckwheat seedlings were obtained after irradiation of the seeds with the γ rays of ^{60}Co. The dose curves of the UCL and weight of the seedlings have two maxima, while the change in the AOA is of a reciprocal nature. It is suggested that under the action of inhibiting doses of γ rays, the process of utilization of antioxidants is disturbed to a greater degree than their formation, while the values of the UCL and AOA can be used for diagnostic purposes for the selection of doses stimulating the growth of the plants after the irradiation of the seeds. (tr-auth)

18458 IRRADIATED STRAWBERRIES: CHEMICAL, CYTOGENETIC, AND ANTIBACTERIAL PROPERTIES. Schubert, J.; Sanders, E. B.; Pan, S. F.; Wald, N. (Univ. of Pittsburgh). J. Agr. Food Chem.; 21: No. 4, 684-692(1973).

Gamma-irradiated fresh whole strawberries were investigated. Doses of 0.15 and 0.3 Mrad produced no changes in the sugar content of dialysates and freeze-dried powders. Gas chromatography and mass spectrometry of volatile fractions revealed minimal effects of 0.2 Mrad. Volatiles from 1.5 Mrad samples revealed eight compounds not detected in nonirradiated samples. One compound was tentatively identified as methoxyacetaldehyde. Carbonyl compounds were found in dialysates from irradiated (0.2–3.0 Mrad) strawberries with initial G(carbonyl) = 2.2. When the corresponding dialysates were autoclaved in open vessels, the carbonyl levels dropped about 50% at doses >0.5 Mrad. Dialysate preparations (0 to 1.5 Mrad) did not inhibit growth of Salmonella typhimurium LT2. Irradiation made no difference ($p = 0.01$) in the number of chromosomal or chromatid aberrations observed in vitro or in vivo. An increase in chromatid aberrations in vitro was produced by unsealed autoclaved dialysates (0.5 and 1.5 Mrad). Overall, it was found that unlike irradiated dilute solutions of sugars, no significant amounts of cytotoxic agents including α,β-unsaturated carbonyls are formed in low dose (≤0.2 Mrad) strawberries. (auth)

18459 RESPONSE OF VICIA FABA TO IRRADIATION WITH A BEAM OF NEGATIVE π-MESONS, UNDER AEROBIC AND HYPOXIC CONDITIONS. Winston, B. M.; Berry, R. J.; Perry, D. R. (Churchill Hospital, Oxford). Brit. J. Radiol.; 46: No. 547, 541-547(Jul 1973).

Inhibition of root growth in Vicia faba was used to measure relative biological effectiveness and the oxygen enhancement ratio for a beam of negative π-mesons having a relatively wide momentum spread. The radiation in the peak region has an RBE of about 2 relative to that in the plateau and 2 · 5 relative to radium γ rays. The OER is about 2 in the plateau region and about 1 · 7 to 1 · 8 in the peak region. (auth)

Radiation Effects on Animals

Refer also to abstracts 18206 and 18532.

Man

18460 (ANU-P-576) RADIATION AND FALLOUT. Titterton, E. W. (Australian National Univ., Canberra. Research School of Physical Sciences). [nd]. 8p. Dep. NTIS (U. S. Sales Only) $3.00.

The facts relating to levels of natural background radiation and fallout in Australia are presented. Use of the data from fallout measurements in Australia to obtain a quantitative estimate of possible effects on the human population is discussed. Analysis shows that fallout in Australia from all nuclear weapons yet tested (US, Russian, British, French, and Chinese) is very small in terms of the radiation dose received from natural background radiation and medical diagnostic uses of x radiation. In the particular case of French tests, the data show that, if there are any biological effects in Australia at all, these are insignificant in comparison to the everyday risks accepted by the population. (auth)

18461 (BNL-17967) EFFECTS OF IONIZING RADIATION ON HEMOPOIESIS. Cronkite, E. P. (Brookhaven National Lab., Upton, N. Y.). 1973. 21p. (CONF-730637-1). Dep. NTIS $3.25.

From pathobiology of trauma conference; Minneapolis, Minnesota, USA (4 Jun 1973).

The mechanisms of action of ionizing radiations on mammalian systems are reviewed. It is pointed out that all effects have dose-response relationships and may be modified by the type of radiation, the dose rate, the distribution of the absorbed dose within the body, dose fractionation, oxygen tension of the tissues, and other physiological variables. The etiology of the radiation syndrome in man following exposure to a LD_{50} dose of about 300 rads is reviewed, with emphasis on the role of hematopoietic system injury and the progressive development of granulocytopenia, thrombopenia, and lymphopenia. It is pointed out that the probability of members of the general population ever being exposed to radiation doses in the LD_{50} range is extremely small and that only a few personnel have been exposed to doses in this range as a result of radiation accidents. The probability of the development of leukemia following exposure to low-dose radiation is considered. It is concluded that the hazards to human populations from radiation sources existing at present are much less than the hazards from other factors in modern life, with which they are compared. (CH)

18462 (BNWL-1183-15) MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, April 2, 1973–June 30, 1973. Brodzinski, R. L. (Battelle Pacific Northwest Labs., Richland, Wash.). 15 Jul 1973. Contract AT(45-1)-1830. 22p. Dep. NTIS $3.25.

A cosmic radiation dose to the Apollo 17 crew of <1.3 R was calculated from the specific activities of ^{24}Na in their postflight urine specimens. The specific activities of ^{42}K, ^{51}Cr, ^{60}Co, and ^{124}Sb, introduced by injection into the astronauts, are extremely high in these specimens. The ^{59}Fe and ^{137}Cs levels are also reported and appear to be normal. The concentrations of Na, K, Rb, Cs, Ca, Sr, Ba, Cr, Fe, Co, Ag, Au, Zn, Cd, Hg, Sn, As, Sb, Se, Br, Sc, La, Sm,,Eu, Tb, Hf, Ta, and Th were measured in urine specimens from the Apollo 17 astronauts by neutron activation analysis. Strontium, barium, gold, cadmium, lanthanum, samarium, europium, terbium, thorium, and tin are reported for the first time. The concentrations or excretion rates of bromine and the alkali metals exhibit significantly reduced postflight levels and are generally lower than values observed for previous missions. Chromium concentrations reflect radiochromium injections. High levels of arsenic are present in the postflight specimens. No urinary loss of body calcium is evident. Excretion of iron and scandium is similar to earlier missions. Antimony, silver, hafnium, and tantalum elimination rates are lower than previously encountered, and cobalt, zinc, and iron levels are lower than normally anticipated. (auth)

18463 (CONF-720505-, pp 44-54) THYROID NEOPLASMS IN THERAPEUTICALLY IRRADIATED PATIENTS. Seydel, H. G. (Univ. of Pennsylvania, Philadelphia). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

The incidence of thyroid carcinoma in children following external photon beam irradiation and exposure to fallout from atomic explosions was estimated between 1.0 and 7.9 cases per million patient years per rad for doses up to approximately 600 rads. A low incidence was found in 100 adult patients with thyroid neoplasm and in 458 patients who received radiotherapy for malignancies of the head and neck region, among whom only one patient with subsequent thyroid carcinoma could be found. Similarly, there is a low incidence of thyroid malignancy following therapeutic administration of ^{131}I for benign thyroid disorders. (auth)

18464 (CONF-730550-1) REPORT OF THE AUSTRALIAN SCIENTISTS. (Australian Academy of Science, Canberra). 1973. 5p. Dep. NTIS (U. S. Sales Only) $3.00.

From meeting between Australian and French scientists; Canberra, Australia (7 May 1973).

The different interpretations placed on dose commitments and biological effects to the Australian population resulting from fallout from French nuclear weapons tests are presented from the viewpoint of a group of Australian scientists, and from the viewpoint of a group of French scientists. The Australian scientists felt that although the levels of radiation due to the French tests were unlikely to cause a statistically detectable increase in the frequency of cancer or genetic abnormalities, there should be no unwarranted exposure to radiation, especially since the genetic effects though small are cumulative. The French scientists felt that the fallout in no way constituted a danger to the health of populations in the light of natural radiation levels and established dose limits. (AS)

18465 (DHEW-73-8032) ORIGIN AND FINDINGS OF THE ATOMIC BOMB CASUALTY COMMISSION. Jablon, S. (Bureau of Radiological Health, Rockville, MD). Feb 1973. 19p.

The development of the Atomic Bomb Casualty Commission after the Hiroshima and Nagasaki bombings is discussed. Differences between the two events, effects on the populations, epidemiologic implications, study methods, changes in approach, and current functions and responsibilities of ABCC are reviewed. The findings showed: a significantly elevated number of complex chromosomal aberrations in peripheral leukocytes of persons exposed to radiation doses of 100 or more rads; individuals exposed to radiation doses of 100 or more rads at ages under six were about four centimeters shorter than those unexposed when examined 20 years after the bombings; the incidence of cataracts was increased in survivors exposed to doses of 90 rads or more; an increase in the incidence of leukemia in persons exposed to radiation doses of 200 rads or more was manifested two to three years following exposure, and the incidence in persons exposed to 100 rads was higher than that of the general population during the 25 years following exposure; deaths from other cancers over a 20-year period increased fairly regularly in relation to the radiation dose. No other noticeable differences in cause of death or death rates have been observed in the atomic bomb survivors when compared with the general population. (CH)

18466 (LA-UR-73-931) APPLICATIONS OF PARTICLE ACCELERATORS AND PARTICLE COUNTING TECHNIQUES IN BIOLOGY AND RADIATION THERAPY. Raju, M. R. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 39p. (CONF-730541-1). Dep. NTIS $4.00.

From symposium on advanced technology arising from particle physics research; Argonne, Illinois, USA (17 May 1973).

Accelerator-produced particles such as fast neutrons, protons, heavy ions, and negative pions offer some promise in improving the results of radiotherapy. This can be expected either because of superior depth-dose distribution (protons, heavy ions, and negative pions), or the biological effect of high LET particles (neutrons, negative pions, and heavy ions) may be greater on tumor cells (because of the presence of hypoxic cells, bigger shoulder for tumor cell survival, and resistant tumor cell population in the late S phase) for a given effect than on normal cells. Design features of a new instrument that could lead to a better understanding of how cells progress after a given treatment, in addition to diagnostic applications, are described. The instrument is capable of measuring cell volume, cell size, and DNA content, and can be used to separate and analyze cells stained with fluorescent dye. Applications in radiobiological studies using accelerator-produced particles are discussed. (CH)

18467 ABDOMEN WITH RESPECT TO IRRADIATION. Laugier, A. (Hopital Tenon, Paris). Rev. Prat.; 22: No. 28, 3873-3875(1 Nov 1972). (In French).

With regard to the use of radiation for therapy of carcinomas, the organs of the abdominal cavity were considered taboo until recently. This attitude is explained by the high degree of radioresistance of abdominal carcinomas, the high incidence of complications following radiotherapy, and other factors. The situation is slightly different now due to the use of high-energy radiation, which is not limited by the cutaneous factor, and the use of lead shielding as a protection for critical organs. Complications resulting from abdominal radiotherapy are described and the importance of shielding the kidneys during radiotherapy is emphasized. (HLW)

18468 DIAGNOSIS OF FERTILITY DISORDERS FOLLOWING GENITAL INJURIES. Niermann, H.; Nolting, S. Arch. Dermatol. Forsch.; 244: 464-466(1972). (In German).

Among 40 patients who claimed fertility disorders as the result of injuries, two patients indicated that radiation exposure was responsible for their deficiency. In one of the radiation cases, the claim was rejected because of a very low dose. In the other

case, the claim was accepted; he received a high radiation dose after surgical removal of one testis because of a malignant tumor. (HBG)

18469 REDUCTION IN THE SKIN DOSE FROM THE TREATMENT TABLE DURING HIGH ENERGY X-RAY BEAM RADIOTHERAPY. Chavaudra, J.; Delpech, J. P.; Naoun, A.; Dutreix, J. (Institut Gustave Roussy, Villejuif, France). J. Radiol., Electrol., Med. Nucl.; 54: No. 1, 51-56(Jan 1973). (In French).

The principles and experimental aspects of a procedure for reducing the skin dose from a treatment table traversed by a high-energy x-ray beam are presented. A 12-cm-thick expanded polystyrene-mattress is used to reduce the dose delivered to the skin by a 25-MV x-ray beam. The method is not applicable to ^{60}Co γ radiation. (FR)

18470 REPLACEMENT OF RADIUM BY ^{137}Cs IN GYNECOLOGICAL RADIOTHERAPY. Wambersie, A.; Prignot, M.; Gueulette, J. (Univ., Louvain, Belg.). J. Radiol., Electrol., Med. Nucl.; 54: No. 3, 261-270(Mar 1973). (In French).

The isotope ^{137}Cs is as effective as radium when used under the same conditions: same geometry and corresponding activity. Cesium-137 has an advantage from the point of view of radioprotection; it is easy to handle and afterloading techniques can be used. The risks associated with such improvements are small if an accurate geometry (as is currently possible with the use of computers) is employed. Nevertheless great care must be exercised if parameters such as the dose rate or the spacing are modified. (FR)

18471 METHOD OF CALCULATING THE DOSE FIELD OF ^{60}Co GAMMA RADIATION FOR EXTERNAL IRRADIATION THROUGH A GRID. Barkova, A. M.; Cholin, V. V. (Instituts fuer Aerztliche Fortbildung, Leningrad). Radiobiol. Radiother.; 14: No. 3, 228-240(1973). (In German).

The depth dose of ^{60}Co gamma radiation under the open and closed parts of the grid was calculated. The limits were determined from which the influence of shadow effects becomes significant. For quantitative determination of shadow effects in the different tissue depths the projection method was used. A table of the percentage depth doses under grids of different types is given. (auth)

18472 INFLUENCE OF UV LIGHT ON THE OXYGEN UPTAKE OF THE TISSUE IN ARTERIAL OCCLUSIVE DISEASES. Wiesner, S. (Landambulatoriums, Sternberg, Ger.). Radiobiol. Radiother.; 14: No. 3, 295-298(1973). (In German).

UV irradiation of the blood is shown in the literature to effect a stimulation of oxidative processes. According to measurements in arterial occlusive diseases, uv irradiation of the blood and its reinjection leads to improved O_2 utilization in the tissue with disturbed blood flow. It is necessary to make further examinations in order to clarify the mechanism of effect and to draw therapeutical conclusions. (auth)

18473 SILENT SLAUGHTER. Griffiths, J.; Ballantine, R. Chicago; Henry Regnery Company (1972). 233p. $6.95.

The hazards of low-level radiation exposure to the human population are discussed. Among the sources of exposure included in the discussion are television sets, radium watch dials, microwave ovens, faulty x-ray machines, nuclear power plants, and radioactive fallout. The problems associated with the establishment and implementation of government regulations limiting dosages and exposure are also discussed. (ERB)

18474 EXTRACORPOREAL IRRADIATION OF THE BLOOD. Rytilae, A.; Torsti, R. (Univ. Central Hospital, Helsinki). pp 100-102 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

Extracorporeal irradiation of the blood is a valuable method in the treatment of leukemias. Intermittent irradiation is not as effective as continuous irradiation using radioisotope applicators. Therefore, the study of the possibilities of using continuous irradiation methods is important. (ERB)

18475 SOME PHYSIOLOGIC AND PHYSICAL ASPECTS OF THE USE OF HIGH-PRESSURE OXYGEN IN RADIOTHERAPY. Rytilae, A.; Maennikkoe, M. (Univ. Central Hospital, Helsinki). pp 125-127 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The use of hyperbaric oxygen in radiotherapy to increase the radiosensitivity of tumor cells is briefly discussed. Hyperbaric oxygen (3 atmos.) affects large tumor areas to a greater extent than small tumor areas. Considerations attendant to the use of hyperbaric oxygen should be considered in the planning of the radiotherapy since special equipment is required. (ERB)

18476 RADIATION-INDUCED EXTRASKELETAL OSTEOSARCOMA. Alpert, L. I.; Abaci, I. F.; Werthamer, S. (Methodist Hospital of Brooklyn). Cancer; 31: No. 6, 1359-1363(Jun 1973).

A case history is presented of a 41-year-old woman who developed an extraskeletal osteosarcoma of the upper chest wall at the site of therapeutic irradiation for breast carcinoma 8 years previously. The relation of the sarcoma to the irradiation was supported by the coexistence of a profound radiation angiitis. The development of this neoplasm, despite the relatively low total radiation dosage, is distinctly unusual. (auth)

18477 AUTOPSY STUDY OF LEUKEMIA IN ATOMIC BOMB SURVIVORS, HIROSHIMA–NAGASAKI, 1949–1969. Liu, P. I.; Ishimaru, T.; McGregor, D. H.; Yamamoto, T.; Steer, A. (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Cancer; 31: No. 6, 1315-1327(Jun 1973).

Four hundred and seventy-four leukemia autopsies collected from 1949 to the end of 1969 at the Atomic Bomb Casualty Commission (ABCC) in Hiroshima and Nagasaki were studied in relation to dose of radiation at the time of bombing (ATB) using tentative 1965 dose estimates. The leukemia rate was based on autopsy cases belonging to the fixed Life Span Study (LSS) sample and was examined by dose for the period October 1950 to December 1969. There were 61 leukemia cases in 3,959 autopsy cases in this sample. The rate increased by dose, especially in those exposed to more than 100 rads for both 1950–1960 and 1961–1969, even though the autopsy rates differed between these two periods. The pathologic findings were compared by dose for 361 leukemia cases who were born before the bomb including the 61 patients in the LSS sample. Pathologically, no individual leukemia autopsy could be differentiated and designated as being radioinduced in this study. No case of chronic lymphocytic leukemia was detected among cases receiving 1 rad or more. No statistically significant difference related to radiation dose was found in acute leukemia and chronic granulocytic leukemia for various pathologic changes, except for the less intense infiltration of leukemic cells in the lungs of chronic granulocytic leukemia patients. (auth)

18478 RADIOISOTOPES (RI) FOR DIAGNOSIS AND TREATMENT. 9. ^{131}I-Therapy of Hyperthyroidism. Asahara, A. (Central Hospital of JNR, Tokyo). Kotsu Igaku; 26: No. 5, 424-429(Sep 1972). (In Japanese).

Clinical experience with ^{131}I used for the treatment of 80 cases of hyperthyroidism including 30 men and 55 women in ages ranging from 20 to over 60 yrs is reported. The administration dosage is calculated as $100-80 \times$ thyroid weight/24-hr uptake ratio of ^{131}I (%) $\times$ 100, and on the basis of calculation, absorption dose (rad) is obtained as $17 \times T^{eff} \times P \times Q/W$ where T^{eff} is effective half life (day), P is thyroid uptake of ^{131}I (%), Q is administration dosage (μCi), and W is thyroid weight (g). The absorption dose thus calculated was adjusted in order not to exceed 7,000 rad. Iodine-131 was given in the form of $Na^{131}I$ capsule in single administration to most patients, with exception of three cases. The thyroid uptake of the given RI varied from 45 to 98%, the heaviest distribution falling in the range of 65 to 70%. The average thyroid weight, which was calculated by the Allen–Goodwin method, was 55.3g with the range of 25.4 to 112.5g. The result of observation indicated that the treatment proved to be effective in general: 52 cases of complete cure (61.2%), 27 cases of fair result (31.8%), and no effectiveness of one case (1.2%). Major side effects include acute aggravation of disease observed in several patients. However, they were by no means serious and well treated by palliative treatment in relatively short period of time. Hypothyroidism was observed in five cases (5.9%): incidence was within one year following treatment in two cases, two years in one case and over two years in two cases. (JA)

18479 RADIODERMATITIS OF THE HANDS OF DOCTORS: ITS CAUSES AND PREVENTION. Lagrot, F. Bull. Acad. Nat. Med. (Paris); 155: No. 30, 806-810(1971). (In French).

Incidences of doctors suffering from radiodermatitis of the hands are more widespread than is generally believed. A single worker in this field has observed some three hundred cases in twenty years. They have resulted from the repeated exposure to small doses of x rays in screening. The essential pathogenic factor is the effect of ionizing radiations on tissue that is renewed only slowly such as the derm. The frequency of occurrence of radiodermatitis of the hands in relation to radiodermatitis as a whole is 5% and the frequency of cancerous degeneracy is between 25 and 60%. The frequency of occurrence of radiodermatitis of the hands observed for doctors varies with their discipline. Several factors must be considered as aggravating the affection. The only protec-

tion is the rigorous observation of the rules established by the legislating body. Medico-legal problems are posed for doctors affected in this way. (FR)

18480 LATE SKIN CHANGES AFTER RADIOTHERAPY. Electron Microscopic Study. Nagase, K. (Juntendo Univ., Tokyo). Nippon Igaku Hoshasen Gakkai Zasshi; 32: No. 7, 573-586(Oct 1972). (In Japanese).

The skin was picked from a patient when accumulated dose reached to 4000 R under the radiotherapy by ^{60}Co-γ rays, and it was observed through an electron microscope four times, i.e., right after its application, after one year, after two and three years, in order to check changes possibly to be caused on basic membranes and basic cells directly on basic membranes as well. Basic membranes were found not to be affected by ^{60}Co radiation. Basic cells were considerably affected and changed right after application. This type of changes was also observed in basic cells three years after application, thus proving that this change would last for a long time. These changes could possibly be caused by pathological changes in circulation of the blood, since the endothelium cells of capillary vessels of the dermis were found swollen. But basic cells themselves were observed repeating their fission even after three years. Judging from this fact, the change in basic cells caused by the radiotherapy should be regarded as remaining for a long time. (auth)

Vertebrates

Refer also to abstracts 18428, 18435, 18549, and 18561.

18481 (AD-757038) RELATIVE EFFECTIVENESS OF FISSION NEUTRONS FOR GASTROINTESTINAL DAMAGE IN MICE: LETHALITY AND JEJUNAL CRYPT RESPONSE. Zeman, G. H.; Jones, S. R.; George, R. E.; Levin, S. G. (Armed Forces Radiobiology Research Inst., Bethesda, MD). Sep 1972. 20p. (AFRRI-SR-72-15). NTIS.

Mice were unilaterally irradiated in either a high neutron or a high gamma field. Median doses for gastrointestinal lethality (LD50/6) were 350 rads and 882 rads for the neutron and gamma ray fields, respectively, following single pulsed exposures. Thus, the relative effectiveness of the neutron field at the LD50/6 dose level was 2.5. The percentage of jejunal crypts destroyed at various neutron and gamma ray doses was also determined. The relative effectiveness of the neutron field associated with jejunal crypt destruction ranged from 3.1 to 10% crypt destruction to 2.1 at 90%. A direct relation between destruction of jejunal crypts and animal lethality was demonstrated. (auth)

18482 (AD-757039) DEPENDENCE OF MINIATURE PIG PERFORMANCE DECREMENT ON GAMMA-RAY DOSE RATE. George, R. E.; Chaput, R. L.; Barron, E. L. (Armed Forces Radiobiology Research Inst., Bethesda, MD). Dec 1972. 21p. (AFRRI-SR-72-20). NTIS.

Trained miniature swine were irradiated in a nuclear reactor-produced gamma field. Dose rates at the midline of the brain were 470, 1000, 1500, 2000, or approximately 10,000,000 (pulsed irradiation) rads/minute. Doses ranged from 1500 to 14,700 rads. Postirradiation performance data were used to calculate for each dose rate the most probable dose that would cause 50% of the animals to perform unsatisfactorily (ED50). The response varied markedly with dose rate at less than 2000 rads/minute; ED50's were 10,570, 7780, 2500, and 2380 rads, respectively, for 470, 1000, 1500, 2000, and 10 to the 7th power rads/minute. Survival times, however, did not appear to be dependent on dose rate. (auth)

18483 (AD-757325) EFFECT OF SUPRALETHAL DOSES OF IONIZING RADIATION UPON MITOCHONDRIA OF THE RAT CENTRAL NERVOUS SYSTEM. Cohan, S. L.; Catravas, G. N.; Abbott, J. R.; Ricks, E. E. (Armed Forces Radiobiology Research Inst., Bethesda, MD). Jul 1972. 16p. NTIS.

The effect of supralethal doses of ionizing radiation on the function of rat central nervous system (CNS) mitochondria was studied. Following 20,000 rads to the head there was a significant transient decrease in respiratory control, with a return to control levels by 4 hours after irradiation. Despite this apparent return to normal respiratory function the animals continued to deteriorate clinically, dying of the radiation CNS syndrome within 48 hours. In animals receiving 10,000 rads to the head, there were no apparent abnormalities in the respiratory function of the mitochondria. The results suggest that mitochondria of the CNS are quite radioresistant when compared to those of other tissues, and this may in part explain the greater radioresistance of the CNS when compared to other organs. (auth)

18484 (AEC-tr-7430) RADIOBIOLOGY. Translation of Radiobiologiya; 13: No. 1, 3-160(1973). 218p. Dep. NTIS $7.60.

Separate abstracts were prepared for the 35 papers in this issue. (ERB)

For abstracts of individual papers see: 17982, 18428, 18429, 18443, 18444, 18454-18457, 18485-18509, and 18546.

18485 (AEC-tr-7430, pp 1-7) INFLUENCE OF WHOLE-BODY X IRRADIATION ON THE NUCLEOTIDE COMPOSITION AND ABILITY FOR MOLECULAR HYBRIDIZATION OF THE FRACTIONS OF NUCLEAR RNA OF THE REGENERATING RAT LIVER. Komar, V. E.; Sedova, V. M. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Translated from Radiobiologiya; 13: No. 1, 3-7(1973).

Whole-body x irradiation of rats at a dose of 1000 rad 3 to 6 hrs after partial hepatectomy leads to a displacement of the nucleotide composition of the new-formed nuclear RNA of the liver in the direction of the GC type and a decrease in the ability of ^{32}P-RNA for hybridization with homologous DNA. In experiments with competitive hybridization it was established that radiation prevents the appearance of new types of nuclear D-RNA in the early period of regeneration of the liver. (tr-auth)

18486 (AEC-tr-7430, pp 8-13) INTENSITY OF DNA SYNTHESIS IN RADIOSENSITIVE TISSUES OF RATS IRRADIATED AT VARIOUS DOSES. Golyshev, E. P. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 13: No. 1, 8-11 (1973).

The intensity of DNA synthesis in the radiosensitive tissues of rats was studied, considering dilution of the introduced ^{14}C-thymidine by the endogenous analog. It was shown that the reduction of the intensity of the incorporation of ^{14}C-thymidine into the DNA of the spleen, thymus, and bone marrow of γ-irradiated rats (100, 300, and 900 R) is due to a substantial degree to dilution of the label by endogenous thymidine. It was established that after the decrease in the rate of DNA synthesis 3 hrs after irradiation in all doses, a relative increase in it is observed by 6 hrs after irradiation. (tr-auth)

18487 (AEC-tr-7430, pp 14-22) INFLUENCE OF IONIZING RADIATION AND BETA-MERCAPTOETHYLAMINE ON THE INCORPORATION OF 1-^{14}C-D,L-LYSINE INTO THE PROTEIN FRACTIONS OF ISOLATED NUCLEI OF THE RAT SPLEEN. Mikhailova, L. P.; Blokhina, V. D.; Romantsev, E. F. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 13: No. 1, 12-18(1973).

The incorporation of 1-^{14}C-D,L-lysine into the protein fractions of isolated spleen nuclei after irradiation of intact rats and rats that received prophylactic administration of β-mercaptoethylamine was investigated. In the control, 15 to 20 min after irradiation, a distinct inhibition of the synthesis of all nuclear proteins, with the exception of the residual proteins, was observed. When MEA was administered, a decrease in the rate of synthesis of nuclear proteins was noted in comparison with the corresponding fractions of unprotected rats. An exception was the most radiosensitive fraction I of acid-soluble proteins, the synthesis of which was restored to a normal level. A restoration of the synthesis of all the nuclear proteins in comparison with irradiated unprotected animals (by 120 to 130%) was observed 48 hrs after irradiation. (tr-auth)

18488 (AEC-tr-7430, pp 23-29) COMPARATIVE INVESTIGATION OF THE EFFECTS OF LOCAL X IRRADIATION AND CERTAIN INHIBITORS OF TRANSCRIPTION AND TRANSLATION ON THE ACTIVITY OF DEHYDROGENASES OF THE KREBS CYCLE IN THE BRAIN. Aleksandrov, S. N.; Eshchenko, N. D. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Translated from Radiobiologiya; 13: No. 1, 19-23(1973).

Local x irradiation of the brain of white rats at a dose of 20 kR significantly reduced the activity of dehydrogenases of the Krebs cycle both in the cerebral cortex and in the subcortex, 4 hrs after the influence. The succinic dehydrogenase activity was practically unchanged. An inhibitor of transcription, actinomycin D, in doses causing a comparable decrease in the total protein synthesis, also did not influence succinic dehydrogenase, but, like irradiation, suppressed the activity of the remaining dehydrogenases. An inhibitor of translation, puromycin, had little influence on the activity of all the enzymes studied. The data obtained are discussed as one of the indices of fine disturbances of the process of transcription after irradiation. (tr-auth)

18489 (AEC-tr-7430, pp 37-44) THERAPEUTIC ACTION OF HETEROLOGOUS DNA IN FRACTIONATED PROLONGED IRRADIATION. Kirillova, E. N.; Libinzon, R. E. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 13: No. 1, 29-34 (1973).

In acute radiation sickness in rabbits, caused by fractionated prolonged irradiation at summary doses of 1330 to 1700 rad, a therapeutic effectiveness of high-polymer DNA was detected. The greatest effect was noted when the rabbits were irradiated at a dose of 1330 rad with subcutaneous or intramuscular injection of the biopolymer. (tr-auth)

18490 (AEC-tr-7430, pp 45-52) INVESTIGATION OF CERTAIN PHYSICOCHEMICAL AND PROTECTIVE PROPERTIES OF THE DNA OF TISSUES OF ANIMALS OF DIFFERENT AGES IN THE CASE OF NEUTRON IRRADIATION. Khilobok, I. Yu.; Ryabova, E. Z.; Chebotarev, E. E.; Shevchuk, O. P. (Inst. of Gerontology, Kiev). Translated from Radiobiologiya; 13: No. 1, 35-40(1973).

The protective action of DNA preparations administered to rats before neutron irradiation at a dose of 215 rad was studied. The DNA, isolated from tissues of young rats, has a radioprotective effect, stimulates processes of division, and accelerates repair in the irradiated animals. A similar effect is not exhibited by DNA isolated from the tissues of old rats. It was found in experiments in vitro that the radiosensitivity of liver DNA does not depend on the age of the animals. However, the DNA of the mucosa of the small intestine of old animals proved to be less resistant to the action of neutron irradiation than the DNA of the same tissue of young animals. (tr-auth)

18491 (AEC-tr-7430, pp 53-59) DYNAMICS OF ANTIBODY-FORMING CELLS AND TITER OF HEMOLYSINS IN IRRADIATED ANIMALS TREATED WITH DNA. Tkach, L. A.; Muksinova, K. N. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 13: No. 1, 41-45(1973).

An earlier restoration of antibody formation was observed in rats irradiated at a dose of 715 R ($LD_{55/30}$) and treated with DNA. The amount of antibody-forming cells and titer of hemolysins in the experimental animals was higher than in the control irradiated animals at all periods of the investigation. (tr-auth)

18492 (AEC-tr-7430, pp 60-65) INFLUENCE OF RADIOPROTECTIVE SYMPATHICOMIMETICS AND THEIR COMBINATION OF THIOLS IN THE SPLEEN. Kulinskii, V. I.; Zolochevskaya, L. I. (Ukrainian Inst. for the Advanced Training of Physicians, Khar'kov). Translated from Radiobiologiya; 13: No. 1, 46-49(1973).

Radioprotective sympathicomimetics increase the concentration of protein thiols in the spleen: isadrin through the β-adrenoreceptors, and noradrenaline and mesaton through receptors distinct from the classical ones. The degree of expression of this effect and its changes under the influence of adrenolytics is correlated with the radioprotective action but not with the decrease in the oxygen pressure. In the spleen, evidently the thiol-increasing effect of SM is not a consequence of hypoxia. (tr-auth)

18493 (AEC-tr-7430, pp 6-73) RADIOPROTECTIVE PROPERTIES OF ZYMOSAN. Chertkov, K. S.; Khramchenkova, S. P.; Rogozkin, V. D. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 13: No. 1, 50-55(1973).

A radioprotective action of zymosan was established in experiments on mice; it increases the survival of the animals by 11 to 28%, reduces processes of postradiation depopulation of the spleen and bone marrow, and promotes a conservation of a large number of CFU in them. The effectiveness of zymosan depends on the dose of the preparation, the method and time of administration before irradiation, and the dose of irradiation. (tr-auth)

18494 (AEC-tr-7430, pp 74-80) MORPHOLOGICAL CHANGES IN THE ADRENALS UNDER THE COMBINED INFLUENCE OF THERMAL BURN AND X IRRADIATION. Kreova, A. N.; Muzykant, L. I. (Inst. of Surgery imeni A. V. Vishnevskii, Moscow). Translated from Radiobiologiya; 13: No. 1, 56-60(1973).

The morphological changes in the adrenals in the case of combined lesion (irradiation at a dose of 900 R and burn of 20% of the body surface, irradiation at a dose of 700 R and burn of 10% of the body surface) were studied. Substantial dystrophic changes in the adrenal cortex were detected 20 to 25 hrs, 2, 3, 7 days after the trauma. Simultaneously with the dystrophic changes, compensatory processes arose in the adrenal cortex; 14 to 30 days after the trauma, there was a normalization of the structure of the adrenals. (tr-auth)

18495 (AEC-tr-7430, pp 81-86) STUDY OF THE RADIOSENSITIVITY OF THE GERM AND SOMATIC CELLS OF MICE OF DIFFERENT LINES. Domareva, O. P.; Dmitrieva, T. I. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 13: No. 1, 61-65(1973).

Data are cited on the influence of x rays on the radiosensitivity of the germ (reticular epithelium) and somatic (corneal epithelium) tissues in mice of four lines. The lines of mice were found to differ in tissue radiosensitivity. (tr-auth)

18496 (AEC-tr-7430, pp 87-93) PERMEABILITY OF THE INTESTINAL WALL TO ENDOTOXINS OF GRAM-NEGATIVE BACTERIA IN NORMAL AND LETHALLY IRRADIATED ANIMALS. Meter, I. D.; Domanskii, V. Yu. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Translated from Radiobiologiya; 13: No. 1, 66-70(1973).

In connection with the study of the role of endotoxins in the development of the intestinal syndrome of acute radiation sickness, the permeability of segments of small and large intestine was investigated in vitro for the endotoxin S. paratyphy B in the normal state and at various periods after γ irradiation at a lethal dose. The walls of the small and large intestines of intact animals are permeable to bacterial lipopolysaccharides. After the influence of ionizing radiation in an absolutely lethal dose, the permeability of segments of the small intestine was substantially increased, beginning with 48 hrs after irradiation, and continued to increase until the death of the animals. The permeability of the large intestine also increased after lethal doses of radiation, but this occurred later (72 hrs after irradiation) and substantially less intensively than in the small intestine. (tr-auth)

18497 (AEC-tr-7430, pp 94-106) DECREASE IN THE SLOPE OF THE DOSE-SURVIVAL CURVE OF MAMMALS AFTER A CHANGE FROM INSTANTANEOUS WHOLE-BODY UNIFORM IRRADIATION TO NONUNIFORM, FRACTIONATED IRRADIATION OR TO THE EFFECT UNDER CONDITIONS OF THERAPY WITH HEMATOGENIC CELLS. Suslikov, V. I. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 13: No. 1, 71-79 (1973).

From the hypothesis of the leading specific role of the interreplaceable component of radiation lesion in the mechanism of acute radiation death of mammals, the conclusion follows that the slope of the dose-survival curve decreases after a change from instantaneous whole-body uniform irradiation to any nonuniform irradiation. Considerations are cited in support of the fact that this phenomenon should also be observed after a change to a whole-body radiation influence under conditions of therapy with hematogenic cells, to fractionated or prolonged irradiation. The literature data cited and their analysis confirm both conclusions. (tr-auth)

18498 (AEC-tr-7430, pp 112-115) RNA BIOSYNTHESIS IN THE LONG-TERM PERIODS OF ACUTE RADIATION SICKNESS. Likhoded, V. S.; Stolyarov, I. V.; Paskevich, I. F. (Scientific Research Inst. of Medical Radiology, Khar'kov). Translated from Radiobiologiya; 13: No. 1, 84-86(1973).

The biosynthesis of functionally different classes of RNA in the liver and spleen of white rats was studied 48, 72, 96, and 120 hrs after irradiation at a dose of 800 R. It was established that the synthesis of $RNA_{0\text{-}16^{\circ}}$ in both organs is subject to negligible variations, whereas the synthesis of $RNA_{45\text{-}55^{\circ}}$ and $RNA_{55\text{-}65^{\circ}}$ undergoes substantial changes with time after irradiation. (tr-auth)

18499 (AEC-tr-7430, pp 116-20) ACTIVITY OF PANCREATIC AMYLASE IN WHOLE-BODY AND LOCAL IRRADIATION. Mikhailov, V. I. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Translated from Radiobiologiya; 13: No. 1, 87-90(1973).

X irradiation at a dose of 500 R causes a profound inhibition of the amylolytic activity of the pancreas in rats, starting on the fifth day. The development of radiation sickness is accompanied by a drop in the activity of the enzyme in the mucosa of the small intestine and in the blood serum. When the small intestine is perfused, a decrease in the ability of the intestine to hydrolyze starch is noted on the fifth day. Local irradiation of the abdomen induced a drop in the activity of the enzyme in the gland on the third day. Shielding of the region of the pancreas does not prevent changes in its enzymatic activity. (tr-auth)

18500 (AEC-tr-7430, pp 131-135) PARTICIPATION OF SERUM ALBUMIN IN PROCESSES OF SYNTHESIS OF LIVER PROTEINS DURING ACUTE RADIATION SICKNESS. Yaralova, P. V.; Pinchuk, L. B. (Kiev Scientific Research Inst. of Hematology and Blood Transfusion). Translated from Radiobiologiya; 13: No. 1, 99-101(1973).

A model of hypoalbuminemia, induced by irradiation of rabbits at an absolutely lethal dose (1200 R), was used to determine the participation of parenterally administered serum albumin in processes of synthesis of liver proteins. It was shown that parenterally administered albumin-^{131}I is actively utilized by the protein-synthesizing systems of the liver during the first week of development of acute radiation sickness. In the case of a transfusion of serum albumin, the ability for its utilization in the organism is also retained at the height of the sickness, in contrast to the control group of animals. (tr-auth)

18501 (AEC-tr-7430, pp 141-145) AGGRAVATING EFFECT OF CORTICOSTEROIDS ON THE COURSE AND OUTCOME OF ACUTE RADIATION SICKNESS. Vlasenko, S. P.; Khachkavanktsyan, A. S.; Aidinyan, R. A.; Ter-Sarkisyan, A. O. (Inst. of Roentgenology and Oncology, Erevan). Translated from Radiobiologiya; 13: No. 1, 106-109(1973).

The statistical difference in the content of certain components of carbohydrate-energy metabolism in the brain tissues of irradiated animals and animals that received hormonal preparations

daily after irradiation, hydrocortisone and DOCA, were determined on the basis of experimental results. It was shown that corticoids and especially glucocorticoids, aggravate the post-radiation disturbance of carbohydrate-energy metabolism in brain tissue. The lifetime of the irradiated animals that received DOCA, and especially hydrocortisone, daily is appreciably shortened. (tr-auth)

18502 (AEC-tr-7430, pp 146-150) CYTOPLASMIC-NUCLEAR RATIO IN THE INFRAMESENTERIC SYMPATHETIC GANGLIA OF RABBITS IRRADIATED AT A DOSE OF 1400 R. Evdokimova, G. A. (Inst. of Microbiology and Virology, Kiev). Translated from Radiobiologiya; 13: No. 1, 110-113(1973).

Examination of the inframesenteric sympathetic ganglia of rabbits irradiated at a dose of 1400 R, using karyometric and neurohistological methods, showed that the cells of this portion of the autonomic nervous system undergo chiefly changes of the type of "hydropic swelling." The size of the nuclei of the neurocytes changes negligibly, which permits the absence of extreme changes in the metabolism of the cells studied to be assumed. The index of the cytoplasmic-nuclear ratios also changes inconsequentially, and it is the lowest at the height of radiation sickness (7th day). (tr-auth)

18503 (AEC-tr-7430, pp 152-155) INFLUENCE OF NICOTINIC ACID AND β-ADRENERGIC BLOCKAGE ON THE LIPOMOBILIZATION AFTER PROLONGED IRRADIATION OF RATS. Ahlersova, E.; Ahlers, I.; Sedlakova, A.; Malatova, Z.; Praslicka, M.; Totova, E. (Safarik Univ., Kosice, Czech.). Translated from Radiogiologiya; 13: No. 1, 113-116(1973).

The administration of nicotinic acid to rats immediately after the end of prolonged irradiation (60 R daily up to a total dose of 1500 R) caused a decrease in the content of free fatty acids in the blood serum, white adipose tissue, and cardiac muscle of the animals and a decrease in the serum triglycerides. In animals starved for the night before the experiment, the administration of nicotinic acid produced a decrease in the concentration of free fatty acids in the serum, white adipose tissue, liver, cardiac muscle, and a decrease in the fatty acid esters in the liver. A simultaneous administration of the β-adrenergic blocker propanolol did not cause any changes in the lipids of the serum and investigated tissues induced by irradiation. The sympathetic nervous system apparently does not play an important role in the lipomobilization of continually irradiated rats. (tr-auth)

18504 (AEC-tr-7430, pp 156-160) METABOLIC CHANGES IN LIPIDS AFTER PROLONGED GAMMA IRRADIATION OF RATS. Ahlers, I.; Ahlersova, E.; Sedlakova, A.; Praslicka, M. (Safarik Univ., Kosice, Czech.). Translated from Radiobiologiya; 13: No. 1, 116-119(1973).

Male rats of the Wistar line were irradiated on an open experimental field at a dose of 1500 R with a dose rate of 60 R/day. In an analysis of the animals immediately after the end of irradiation, an increased content of blood glucose and of most of the lipids in the serum, especially free fatty acids, was detected. An increased content of cholesterol in the adrenals and lipoperoxides in the liver and kidneys was detected. A week after irradiation, the content of blood glucose and adrenal cholesterol returned to normal. A decrease in the activity of glucose-6-phosphate dehydrogenase was noted in the erythrocytes. In animals subjected to brief hypokinesia after the end of irradiation, metabolic manifestations of a stress reaction, characteristic of an isolated action of brief hypokinesia, were observed. (tr-auth)

18505 (AEC-tr-7430, pp 167-172) RADIOPROTECTIVE ACTIVITY OF CERTAIN NEW THIURONIUM DERIVATIVES. Shashkov, V. S.; Fedoseev, V. M.; Gorelova, N. V.; Vasin, M. V.; Semenenko, M. N.; Churilin, V. S. (Moscow State Univ.). Translated from Radiobiologiya; 13: No. 1, 123-137(1973).

The toxicity and radioprotective effect of 16 new monothiuronium, 1,2-, and 1,3-dithiuronium derivatives of the propane series, containing carboxyl, ester, and substituted amine groups, as well as certain heterocylic radicals, in the carbon chain, were studied. Dithiuronium compounds proved to be 5 to 10 times more toxic than AET and exhibited practically no radioprotective effect in the γ irradiation of mice at a dose of 850 to 900 R. Among the less toxic monothiuronium derivatives, the effectiveness of the most active preparations did not exceed 50% of the effectiveness of AET. (tr-auth)

18506 (AEC-tr-7430, pp 173-175) REDUCTION OF THE RADIOPROTECTIVE ACTIVITY IN THE CASE OF SIMULTANEOUS INTRODUCTION OF CYSTAMINE AND 5-METHOXYTRYPTAMINE INTO THE STOMACH. Davydov, B. I.; Kozlov, V. A. Translated from Radiobiologiya; 13: No. 1, 127-129(1973).

It was shown in experiments on mice that the simultaneous intragastric introduction of cystamine and mexamine, which have different rates of absorption and elimination, creates conditions for a crossed increased resistance of the organism to the protector and reduces the radioprotective effect of a complex of these preparations. (tr-auth)

18507 (AEC-tr-7430, pp 176-178) INFLUENCE OF THE PRELIMINARY ADMINISTRATION OF MEXAMINE ON THE TOXICITY OF THE PREPARATION IN THE CASE OF ITS REPEATED USE FOR IRRADIATED AND NONIRRADIATED ANIMALS. Vasin, M. V. Translated from Radiobiologiya; 13: No. 1, 129-131 (1973).

The influence of γ irradiation on phenomena of tachyphylaxis in the case of repeated administration of mexamine was studied in experiments on mice (according to the change in the toxicity of the radioprotector in the case of various time intervals between administration of the substance: 15, 45 min, and 3 hrs in a period of 3 hrs after the influence of radiation). The tachyphylaxis phenomena noted after two administrations of mexamine were more pronounced among the irradiated animals. (tr-auth)

18508 (AEC-tr-7430, pp 179-184) QUANTITATIVE HISTOLOGICAL ANALYSIS OF THE ACTION OF GAMMA IRRADIATION AND CYSTEINE ON MOUSE TESTES. Mamina, V. P. (Inst. of the Ecology of Plants and Animals, Sverdlovsk, USSR). Translated from Radiobiologiya; 13: No. 1, 131-135(1973).

Male mice of the BALB line were subjected to γ irradiation at a dose of 610 R. Cysteine was injected intraperitoneally 5 min before irradiation in a dose of 900 mg/kg. Irradiation caused the disappearance of spermatogonia by the eighth day, which resulted in a successive disappearance of a number of spermatocytes (16th day), spermatids (24th day), and spermatozoa (32nd day). Cysteine (statistically significantly) maintained the number of cells at a higher level at the maximum of the drop in their number; moreover, it eliminated the increase in the area of the seminiferous tubules and their lumen on the first and eighth days after irradiation. (tr-auth)

18509 (AEC-tr-7430, pp 190-193) RADIOSENSITIVITY OF BONE MARROW CELLS OF GUINEA PIGS, FORMING COLONIES OF FIBROBLASTS IN MONOLAYER CULTURES. Konoplyannikov, A. G.; Rudakova, S. F. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 13: No. 1, 138-140(1973).

The dose dependence of the survival of cells forming colonies of fibroblasts in monolayer cultures of guinea pig bone marrow was studied. D_0 for the cells obtained from the perimural and central portions of the bone marrow of the femur is 122 and 128 rad, respectively, while the extrapolation number is 3.5 and 2.5, respectively. The radiosensitivity of bone marrow cells of guinea pigs capable of forming colonies of fibroblasts is close to the radiosensitivity of the hematogenic stem cells of rodents and man. (tr-auth)

18510 (AECL-4220) EFFECTS OF CHRONIC INGESTION OF ORGANIC REACTOR COOLANT (HB-40) ON MICE (MUS MUSCULUS). Part I. Iverson, S. L.; Turner, B. N. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Jun 1973. 63p. Dep. NTIS (U. S. Sales Only) $5.25. AECL $1.50.

Groups of out-bred house mice (Mus musculus) were chronically exposed to three different concentrations (approximately 1.0, 0.1, and 0 mg/l) of equilibrium organic reactor coolant (HB-40) in their drinking water for three generations. Coolant concentrations of this order of magnitude could be detected by the mice but did not cause a reduction in their fluid intake. The dose rates to adult mice were approximately 0.25 mg/kg/day, while those to young were higher. No treatment effects were seen in litter size, number of litters produced, weight of young, sex ratio, or weight gain to weaning. X-ray $LD_{50/30}$'s were higher in animals exposed to coolant but not significantly so. When the mice were given consecutively more concentrated NaCl solutions to drink, there were no differences in death rate or weight loss among treatments, indicating that functional kidney damage had not occurred. No effects were seen in intraspecific aggressive responses or voluntary activity. An effect of coolant ingestion was observed in an open-field test, but the effect could not be demonstrated when the open-field experiment was repeated. Evidence to date indicates that chronic consumption of water containing as much as 1.0 mg/l organic coolant has no deleterious effect on this species. (auth)

18511 (BNL-17987) DIFFUSION CHAMBER TECHNIC AS PROGENITOR (STEM) CELL ASSAY. Boeyum, A.; Pettersen, E. O.; Laane, B.; Carsten, A. L. (Brookhaven National Lab., Upton, N. Y.). 1973. 15p. (CONF-730548-2). Dep. NTIS $3.00.

From 2nd international workshop on hemopoiesis in culture conference; Warrenton, Virginia, USA (23 May 1973).

The hemopoietic response in mice to x-irradiation and treat-

ment with hydroxyurea or cyclophosphamide was studied by comparing the diffusion chamber (DC) technic and the spleen colony technic. The hydroxyurea experiments showed that DCPCs (diffusion chamber progenitor cells) had a higher proliferative rate than spleen colony forming units (CFUs). The radiation response indicated that 7 day DC culturing measures two different types of progenitor cells, one relatively radioresistant with D_0 of 135 rads and one with radiosensitivity comparable to that of CFUs (50 rads). Two hours after cyclophosphamide treatment, erythroid CFUs were almost eradicated indicating that cyclophosphamide selectively blocked the ability of multipotent stem cells to erythroid differentiation. The number of granuloid CFUs and DCPCs were less affected. It is concluded that DC culturing probably measures a mixture of multipotent and unipotent stem cells. (auth)

18512 (CONF-720505-, pp 55-89) RADIATION-RELATED AND SPONTANEOUS TUMORS IN PRIMATES. Splitter, G. A.; Kirk, J. H.; Casey, H. W. (School of Aerospace Medicine, Brooks AFB, TX). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Out of an original group of 1000 Macaca mulatta exposed to various types of whole-body irradiation (5- to 2300-MeV protons, 25 to 3000 rads; 1.2- to 1.6-MeV electrons, 25 to 2000 rads; neutrons; and 2-MeV x ray, 25 to 800 rads), 18 monkeys have developed 19 tumors. Thirteen tumors were considered to be radiation induced and were classified as follows: myxosarcoma (395 rads, 2.3-GeV proton exposure), sarcoma (1500 rads, 1.6-MeV electron exposure), two fibrosarcomas (600 rads, 55-MeV proton exposure), two glioblastomas multiforme (800 rads, 55-MeV proton exposure), two glioblastomas multiforme (600 rads, 55-MeV proton exposure) leukemia (608 rep, neutron exposure), leukemia (100 rads, 400-MeV proton exposure), mammary ductule carcinoma (560 rads, 32-MeV proton exposure), neurofibroma (990 rads, 32-MeV proton exposure), and fibroma (1800 rads, simulated solar-flare protons, 10% of 105 MeV and 90% of 10 MeV). The remaining six tumors were not considered radiation related. No tumors developed in the control monkeys. Over 270 tumors of a spontaneous nature have been reported in monkeys, compared with 34 in externally irradiated monkeys. (auth)

18513 (CONF-720505-, pp 90-105) LIFE-SPAN MEASUREMENTS AND SKIN TUMORIGENESIS IN MICE FOLLOWING TOTAL-BODY HELIUM-ION IRRADIATION OF THE SKIN TO DIFFERENT MAXIMUM PENETRATION DEPTHS. Leith, J. T.; Welch, G. P.; Schilling, W. A.; Tobias, C. A. (Univ. of California, Berkeley). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Some effects of whole-body irradiation of the skin of mice were investigated. Skin was irradiated to different maximum penetration depths (i.e., 51, 31, 22, and 12 mg/cm^2) using a 40-MeV helium ion beam to examine the effects of penetration depth in skin on long-term responses, such as life shortening and skin tumorigenesis. A definite life-shortening effect could be found at each of the penetration depths used. For the 51 mg/cm^2 penetration, a life shortening of 2.6% of the median life-span per 100 rads was found. For the 31 mg/cm^2 penetration depth, a life shortening equal to 2.2% of the median life-span per 100 rads was found. For the 22-mg/cm^2 and 12-mg/cm^2 penetration depths, life shortening was observed, but the dose–response relation was not linear. In 380 mice irradiated with varying doses at the 51 mg/cm^2 penetration depth, 104 tumors were found. Of these, 16 were papillomas that regressed and disappeared over the duration of the experiment. The papillomas were seen only after irradiation at this depth. With decreasing penetration depth, the incidence of tumors decreased. The incidences [(number of tumors)/(number of mice)] were 60/263, 14/213, and 2/203 for depths of 31, 22, and 12 mg/cm^2, respectively. Of the nonpapilloma tumors, the majority of growths were dermal. No tumors were found in nonirradiated control mice. A definite reduction in skin-tumor incidence was found after irradiation at the 51 mg/cm^2 depth when mice were kept in a cold environment (2°C) compared to when they were kept at 20°C. (auth)

18514 (CONF-720505-, pp 391-405) INDUCTION OF NEUROGLIAL TUMORS BY IMPLANTED ^{60}Co RADIATION SOURCES. McDonald, L. W.; Lippert, W.; Brownson, R. H.; McDougal, H. D. (Univ. of California, Davis). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Malignant gliomas were induced in 19 of 27 rats by implanted ^{60}Co γ radiation sources in the occipital area of the cerebrum. The findings indicate that chronic irradiation must be at a relatively low dose rate to the subependymal plate to induce these tumors. Inclusions suggestive of virus, the high incidence of tumors, and the known interaction of virus and radiation in the induction of leukemia and the transformation of cells in tissue culture raised the possibility of a virus interacting with the radiation to produce these neoplasms. (auth)

18515 (RLO-2225-T-2-5) LOW LEVEL CHRONIC IRRADIATION OF SALMON. Annual Progress Report. Hershberger, W. K.; Donaldson, L. R.; Bonham, K.; Brannon, E. L. (Washington Univ., Seattle. Coll. of Fisheries). 22 Jun 1973. Contract AT(45-1)-2225. 33p. Dep. NTIS $3.75.

Salmon eggs and alevins were exposed to chronic γ irradiation, at doses ranging from 5 R/day in 1967 to 50 R/day in 1970, during the entire 71-day incubation period. The young fish were released to the ocean and those that returned as adults were examined. Chronic irradiation retarded the growth rate of smolts and affected survival in the ocean, as demonstrated by the number that returned each year. Preliminary results are reported from studies on the genetic effects of irradiation in the progeny of irradiated parents and crosses of irradiated parents. (CH)

18516 (SAN-410-157) BASIC STUDIES OF THE IMMUNE RESPONSE AND THE EFFECTS OF RADIATION ON THIS RESPONSE. Comprehensive Report, October 1, 1970–May 31, 1973. Dixon, F. J.; Weigle, W. O. (Scripps Clinic and Research Foundation, La Jolla, Calif.). 27 Jun 1973. Contract AT(04-3)-410. 24p. Dep. NTIS $3.25.

Progress is reported on the following research projects: nature of the immunodeficiency caused by lethal x irradiation of mice and the cellular requirements for reconstitution of the immune response; effects of x radiation on the immune functions of macrophages and lymphocytes; and immunopathologic characteristics of chronic viral infections and the effect of radiation and drug-induced immunosuppression on these infections. (HLW)

18517 NEW METHOD OF LONG-TERM IRRADIATION OF THE PERIPHERAL BLOOD OF THE MOUSE WITH ^{32}P. Observation on the Changes of Lymphocytes and the Thymus Response by this Method. Kojima, M.; Tachibana, F.; Nishimura, K.; Saito, T.; Dobashi, M. (Fukushima Medical Coll., Japan). RES, J. Reticuloendothel. Soc.; 13: No. 3, 193-209(1973).

A method of prolonged and continuous irradiation of circulating blood with ^{32}P was devised and a continuous diminution in the number of the peripheral blood lymphocytes and changes of the lymphoid tissues, particularly the thymus was observed. Adult mice and thymectomized adult mice were fixed and bred in containers made of plastic. The tails of these mice were extended out from the containers; sandwiched in between a pair of filter papers soaked into ^{32}P solution; and screened from the bodies by a wall made of paraffin. In this way, ^{32}P irradiation of the blood vessels of part of the mouse's tail was continuously maintained for a period of 10 days. In adult mice, a marked decrease in the number of the lymphocytes, particularly small lymphocytes in the peripheral blood occurred, but after the completion of irradiation the peripheral blood-lymphocyte levels gradually returned to the pre-irradiation level. The thymus showed a marked involution, running parallel with the decrease of the small lymphocytes in the peripheral blood. Histologically, there was a very extensive depletion of the lymphocytes in the cortex, and at last the cortex was composed almost only of reticulum cells. During this time, cells with karyorrhectic nuclear degeneration were not found. After the completion of irradiation, the thymus showed immediately a prosperous regeneration, and on the third day was nearly restored to normalcy. On the other hand, the involution of the lymph nodes and the spleen was slight. In thymectomized adult mice, the decrease in the number of the lymphocytes, especially small lymphocytes in the peripheral blood was more striking. Also after completion of irradiation, the peripheral blood-lymphocyte levels had not returned to the pre-irradiation level, and this tendency was frequently found among others in the small lymphocytes. In this case, the lymph nodes and the spleen as well, showed a marked involution, and there was recognized a striking depletion of the lymphocytes in the mid and deep cortex of the lymph nodes and in the area around the central arteriole within the splenic follicle. This depletion was remarkable especially after the completion of irradiation. It is concluded that the thymus originally may be providing the lymphocytes for the peripheral blood, and thus when the lymphocytes in the peripheral blood are depleted in large quantities, the thymus may respond sensitively to this lymphocyte depletion, by releasing the lymphocytes in large quantities into the peripheral blood, and becoming the principal source of the supply of lymphocytes. (auth)

18518 EXPERIMENTAL RADIO-OSTEONECROSIS IN RHESUS MACAQUE JAWS; THERAPEUTIC IRRADIATION DOSE EFFECT ON DENTAL EXTRACTION WOUND HEALING. Zach,

L.; Cohen, G.; Scopp, I.; Kaplan, G. (New York Univ., NY). Amer. J. Phys. Anthropol.; 38: 325-330(Mar 1973).

Varying degrees of osteonecrosis result from molar extractions or other oral surgical procedures in rhesus macaques before, during, or after the administration of 6000 rad (the equivalent of human therapeutic dose levels) via either 240 kVp x-ray or cobalt 60 irradiation to the jaw areas subjected to surgery. The effects of various experimental time-dose-wound combinations on the level of impairment of wound-healing, interruption of osteogenesis, and the nature of the response of the irradiation-compromised tissues are covered. (auth)

18519 EXPERIMENTAL REORGANIZATION OF THE CEREBELLAR CORTEX. II. EFFECTS OF ELIMINATION OF MOST MICRONEURONS WITH PROLONGED X IRRADIATION STARTED AT FOUR DAYS. Altman, J.; Anderson, W. J. (Purdue Univ., Lafayette, IN). J. Comp. Neurol.; 149: No. 2, 123-151(15 May 1973).

The heads of Long-Evans rats were irradiated from the fourth day after birth with a schedule of repeated doses of low-level x radiation, which essentially prevented the formation of basket, stellate, and granule cells in all except the earliest-forming lobules (nodulus and uvula). The morphogenic and synaptogenic effects of this treatment were examined with light and electron microscopy in 30 day old animals, with particular attention paid to the pyramis. Although when irradiation was started the Purkinje cells formed a monolayer and had upward oriented apical poles, they became scattered later and had randomly oriented dendrites. No pathological changes were seen in these cerebella, with the possible exception of excessive lobulation of the nuclei of many Purkinje cells. (auth)

18520 EXPERIMENTAL REORGANIZATION OF THE CEREBELLAR CORTEX. III. REGENERATION OF THE EXTERNAL GERMINAL LAYER AND GRANULE CELL ECTOPIA. Altman, J. (Purdue Univ., Lafayette, IN). J. Comp. Neurol.; 149: No. 2, 153-179(15 May 1973).

The heads of Long-Evans hooded rats were irradiated daily from day 3, 4, or 6 onward with schedules of low-level x radiation, which differentially delayed the regeneration of the subtotally eradicated external germinal layer or prevented its regeneration altogether. Most schedules that permitted regeneration led to the arrest of many granule cells in the molecular layer where they formed an ectopic zone. The dendrites of ectopic granule cells had synapses with mossy fibers located in their vicinity in the molecular layer. The position of the ectopic zone varied in different lobules depending on several factors: the time when regeneration began, the estimated date of descent of granule cells, regional differences in cortical maturation and in the estimated upward growth rate of mossy fibers. Within the same lobule, the longer regeneration was delayed the higher in the molecular layer the differentiating and descending granule cells were captured by the apparently autonomously ascending mossy fibers. If regeneration started early and allowed the descent of granule cells into the granular layer (early irradiation) or if regeneration of granule cells was prevented altogether (late irradiation) an ectopic zone was not formed. The technique was used for estimating the normal growth pattern of mossy fibers in the different lobules. (auth)

18521 EXPERIMENTAL REORGANIZATION OF THE CEREBELLAR CORTEX. IV. Parallel Fiber Reorientation Following Regeneration of the External Germinal Layer. Altman, J. (Purdue Univ., Lafayette, IN). J. Comp. Neurol.; 149: No. 2, 181-191(15 May 1973).

The heads of Long-Evans hooded rats were irradiated with a schedule of low-level x radiation, which allowed regeneration of the external germinal layer. In the subsequently regenerated molecular layer, parallel fibers were often reoriented. In some cerebella this was restricted to a single lobule, frequently several lobules were affected, rarely almost the entire vermis. It was postulated that the reorientation of parallel fibers was determined by the invasion route of multiplying cells from spared foci of the external germinal layer. Where parallel fibers were rotated transversely, the axons of basket cells and the arborizing dendrites of Purkinje cells became oriented longitudinally. This, and other considerations indicated that parallel fibers exert a guiding influence on the pattern of growth of the spiny branchlets of Purkinje cells. (auth)

18522 LD_{50} AND CHRONIC TOXICITY OF REACTOR TERPHENYLS. Adamson, I. Y. R. (Univ. of Manitoba, Winnipeg); Weeks, J. L. Arch. Environ. Health; 27: No. 2, 69-73 (Aug 1973).

Acute ingestion of reactor coolant terphenyls (HB-40) revealed LD_{50} values of 17,500 mg/kg rat and 12,500 mg/kg mouse for nonirradiated coolant and 6,000 mg/kg mouse or rat for irradiated coolant. Chronic ingestion of the mixtures by mice produced mitochondrial changes in epithelial cells of proximal tubules, and at high doses these cells became necrotic as interstitial nephritis and scarring developed. The nephritis was irreversible and followed 16 weeks' ingestion of 1,200 mg/kg nonirradiated HB-40 or 600 mg/kg irradiated coolant. Hepatic changes were observed only at the ultrastructural level where abundant smooth endoplasmic reticulum was seen. It appears that organic terphenyl coolants are potentially toxic when ingested in high doses. This could only occur as a result of chronic exposure at a level greatly in excess of that currently observed in the reactor working environment. (auth)

18523 EFFECTS OF ACUTE GAMMA RADIATION ON JAPANESE QUAIL (COTURNIX COTURNIX JAPONICA) IN RELATION TO FUNCTIONAL LEVELS IN A THERMONEUTRAL ENVIRONMENT, AND THERMOREGULATORY RESPONSES TO ABRUPT INCREASE IN AMBIENT AIR TEMPERATURE. Winsor, T. F. Pullman, WA; Washington State Univ. (1973). 290p. University Microfilms Order No. 73-14,785.

Thesis (Ph. D.).

Effects of acute gamma radiation on respiratory rate, heart rate, rectal temperature, feather surface temperature, and oxygen consumption of adult male Japanese quail (Coturnix coturnix japonica) in thermoneutral and hot environments were studied. Functional levels and responses in 25 and 40°C were monitored on consecutive days for minima of 30 minutes. Quail were next exposed to sham (O R), three sublethal, and the midlethal (2320 R) levels of gamma radiation. Functional levels and responses were again monitored at 40°C environmental temperature on the exposure day and at 25 and 40°C on consecutive days at 1 and 2, 7 and 8, 13 and 14, 27 and 28, and 41 and 42 days postexposure. Weight was taken prior to commencement of functional recording and necropsy performed within 24 hours following 40°C stimulation. Functional records postexposure were compared with records collected preexposure and adjusted for control (O R) variation. Quail receiving 2320 R suffered severe functional impairment in heat by day 8 postexposure as mean rectal temperature, surface temperature, and oxygen consumption were significantly lower, 3 of 6 birds did not respond with typical thermal bradycardia, and time delay to high respiratory rate was great. In addition, onset of panting occurred at higher mean rectal temperature, and mean maximum observed respiratory rate was lower. Higher environmental temperatures were necessary to elicit respiratory response to heat. By day 14, functional impairment appeared to be largely ameliorated. However, signs of reappearance occurred on day 28, indicating development of delayed damage, and on day 42 lower mean oxygen consumption and significant delays to onset of panting were again recorded. Necropsy revealed severe heart damage, and associated ascites and pulmonary edema in individuals on days 28 and 42. The greatest weight losses occurred by day 8 in quail dosed at the midlethal level, and later weight gains never resulted in mean weights equaling preexposure values. (Diss. Abstr.)

18524 REDUCED EFFECT OF IRRADIATION ON NORMAL AND MALIGNANT CELLS IRRADIATED IN VIVO IN MICE PRETREATED WITH VITAMIN E. Sakamoto, K.; Sakka, M. (Tohoku Univ., Sendai). Brit. J. Radiol.; 46: No. 547, 538-540(Jul 1973).

The effect of vitamin E in reducing the permeability and increasing the resistance of capillaries might be expected to reduce the blood flow and hence the oxygenation of tissues. The question arises whether pretreatment of mice with vitamin E is associated with a reduced effect of irradiation on the cells of tissues. It was found that pre-treatment with vitamin E increased the LD50 (30) of mice from 565 ± 38 rads (95% confidence) to 630 ± 29 rads. Measurement of fractional survival for cells of murine squamous carcinoma irradiated in vivo in mice breathing air indicated that the percentage of anoxic cells in the tumours was raised from 13% in untreated mice to about 35% in mice pretreated with the vitamin. (auth)

18525 LUNG CANCER INDUCED IN RATS BY THE INHALATION OF RADON. Comparison with the Histological Aspects of Human Cancers. Perraud, R.; Chameaud, J.; Lafuma, J.; Masse, R.; Chretien, J. (CEN, Fontenay-aux-Roses, France). J. Fr. Med. Chir. Thorac.; No. 1, 25-41(Jan 1972). (In French).

Under very well defined experimental conditions, which could be very accurately reproduced, it was possible to obtain experimental tumors in rats, which have certain histological aspects similar to those found in humans having malignant lung cancers. These cancers appear between the tenth and fifteenth month. The existence of previously induced lesions is not necessary. The tumors obtained are always multiply disseminated in the subpleural region, and exhibit muco-epidermoid characteristics, or more exactly simultaneous epidermoid and adenocarcinoma-like

characteristics. This behavior is contrary to that observed with man. The consistency with which tumors were obtained with the experimental set-up contrasts strongly with the scarcity of the spontaneous occurrence of malignant lung tumors in rats. (FR)

18526 CELLULAR KINETICS IN THE BLOOD-FORMING ORGANS AFTER X IRRADIATION. 1. Bone Marrow and Spleen. Kawara, K. (Yamaguchi Univ., Ube, Japan). Igaku Kenkyu; 42: No. 3, 135-149(Nov 1972). (In Japanese).

Male albino mice of dd strain, 6 weeks of age and weighing about 20 g, were used and examined 1, 2, 3, 5, 7, 10, 14, and 21 days after 300 R whole-body x irradiation. A marked decrease in nucleated cell numbers in the bone marrow was observed, a minimum value being obtained at 3 days. The numbers then gradually increased and reached higher values than the control levels after 10 days. Early forms of erythroblasts in the marrow showed little reduction in numbers; whereas, a marked reduction occurred in late forms during the first 5 days. The late neutrophils in the marrow showed a reduction in numbers greater than that of the early neutrophils. The majority of bone marrow lymphocytes are small-sized cells less than 9μ in diameter. These marrow lymphocytes decreased drastically until 7 days after irradiation, followed by a rapid, transient increase at 10 days; and thereafter, they showed once again a marked decrease. The changes in the nucleated cell numbers in the spleen were almost the same as those in the bone marrow. The erythropoietic activity in the spleen considerably exceeded that in the bone marrow. Early forms of neutrophils in the spleen showed a considerable decrease in numbers 2 to 10 days after irradiation; whereas, a marked increase in late forms occurred following the first day. (auth)

18527 CHANGES IN LYMPHOCYTE KINETICS FOLLOWING LONG-TERM IRRADIATION OF THE PERIPHERAL BLOOD STREAM OF THE MOUSE. Nishimura, K. (Fukushima Medical Coll., Japan). Fukushima Igaku Zasshi; 21: No. 5-6, 75-94(Dec 1971). (In Japanese).

A technique of long-term ^{32}P irradiation limited to the tail of the mouse was devised. In the mouse irradiated by this technique, the total leukocyte count of the peripheral blood decreased; especially, the number of lymphocytes decreased continuously. In the non-thymectomized mouse, the same irradiation caused a marked decrease in the number of lymphocytes, especially of small ones, in the peripheral blood. The lymphocyte count of the peripheral circulation, however, gradually returned to the normal level when the irradiation was discontinued. In parallel with this small-lymphocyte decrease, the thymus became atrophic and lymphocyte depletion occurred in the thymic cortex. At the end of irradiation, the thymus revealed regeneration, returning to the normal microscopic picture within a short period. In the thymectomized mouse, the number of lymphocytes in the peripheral blood was more markedly reduced and recovery of the cell count following the end of irradiation was not complete. However, from 50 to 60 days after the end of irradiation, the lymphocyte count approached normal level. The lymph nodes and spleen were remarkably atrophied and the number of lymphocytes markedly decreased in the paracortical areas of the lymph nodes and around the central arteries of the splenic follicles. Such a lymphocytic reduction was prominent after the end of irradiation. From these results, it is clear that the thymus has the ability to supply lymphocytes to the peripheral circulation and to release, as a major source, a large quantity of lymphocytes in the peripheral blood when the number of lymphocytes in the peripheral blood is reduced markedly and continuously. (auth)

Invertebrates

18528 DOMINANT LETHAL MUTATIONS IN INSECTS WITH HOLOKINETIC CHROMOSOMES. I. Irradiation of Oncopeltus (Hemiptera: Lygaeidae) Sperm and Oocytes. LaChance, L. E.; Riemann, J. G. (Metabolism and Radiation Research Lab., Fargo, ND). Contract AT(49-7)-3028. Ann. Entomol. Soc. Amer.; 66: No. 4, 813-819(Jul 1973).

Sexually mature 7- to 8-day-old Oncopeltus fasciatus (Dallas) males and females were irradiated and out-crossed to untreated partners. The males received a dose of 10 krad and the females 1 krad. Egg hatch of females mated to irradiated males was reduced to 2.4% and that of irradiated females to 3.3% (only Metaphase I oöcytes sampled.) Eggs of different ages were dechorionated, fixed, and stained for cytological examination. Most eggs fertilized with irradiated sperm showed a decreased rate of embryonic development, but at least 70% reached the blastoderm stage. In eggs from irradiated females, chromosome aberrations were evident as early as the meiotic divisions that preceded syngamy. Again, early embryonic development was slow but otherwise essentially normal until the blastoderm stage. Thereafter developmental abnormalities occurred, and death ensued. Cells with more or less than the normal 16 chromosomes were not unusual in 18- to 20-hour embryos with irradiated parents. Different cells in the same embryo often had a wide range of chromosome numbers. Apparently, in species with holokinetic chromosomes, most dominant lethal mutations cause death after blastoderm formation. In dipteran and hymenopteran species, dominant lethal mutations are expressed during the early cleavage divisions. (auth)

18529 DIFFERENTIAL RADIOSENSITIVITY OF OOGONIA AND OOCYTES AT DIFFERENT DEVELOPMENTAL STAGES OF THE BRINE SHRIMP, ARTEMIA SALINA. Iwasaki, T. (National Inst. of Radiological Sciences, Chiba, Japan). Biol. Bull.; 144: 151-161(Feb 1973).

Histological changes in the gonads of γ-irradiated Artemia were studied. Three different developmental stages were irradiated; dry eggs, immature young, and adults. Normal growing oocytes and some pycnotic oocytes were found in the ovaries of quite a few surviving adult animals derived from dry eggs irradiated with 100 krads of γ rays. Oogonia and primary oocytes in ovaries of immature Artemia irradiated with 5 krads of γ rays became pycnotic within one day after irradiation, and became greatly reduced in number in 4 days. However, 10 to 14 days after irradiation, some surviving oogonia began to undergo mitosis. In adult animals, although pre-meiotic oocytes were damaged growing oocytes did not show any immediate damage after dose of 5 krads of γ rays. Seven days after irradiation, they reached the mature stage, and normal maturation division occurred. (auth)

18530 EFFECTS OF ACUTE GAMMA IRRADIATION ON THE BRINE SHRIMP, ARTEMIA. III. Male F_1 Reproductive Performance Following Paternal Irradiation of Mature Sperm. Squire, R. D. (Long Island Univ., Brooklyn). Biol. Bull.; 144: 192-199(Feb 1973).

Male brine shrimp (Artemia) were hatched from commercially obtained Californian cysts and irradiated as adults with acute doses of 0, 1, 2, 3.5, 5, or 10 kR gamma rays. Each male was individually pair-mated to a white-eye female. The F_1 were raised to maturity and scored for survival to adulthood, sex ratio, and F_1 male reproductive performance. There was a significant decrease in F_1 survival to adulthood after paternal doses of 3.5, 5 and 10 kR, but not at lower doses. A significant increase in male sex ratio was observed after 5 and 10 kR, and these males were almost completely sterile. A paternal dose of 3.5 kR resulted in a 44% decrease in the number of fertile males and some fertile males were semi-sterile. No apparent effect was observed after 1 or 2 kR. These data support the proposed holokinetic nature of the Artemia chromosome. They also demonstrate that the observable effects of radiation may be much more extreme in the F_1 animals than in the irradiated generation itself. This observation has important implications when assaying the effects of radiation on natural populations. (auth)

18531 UV SENSITIVITY AND NUCLEASE ACTIVITY IN DROSOPHILA. Donini, S. D. Davis, CA; Univ. of California (1972). 107p. University Microfilms Order No. 73-16,901.

Thesis (Ph. D.).

The uv sensitivity of embryos irradiated at different periods of development was determined in various strains of flies. It was observed that the life cycle of the embryos can be divided in three periods of differential uv sensitivity: (1) 1 to 2 hrs after oviposition, where most of the damage produced can be attributed to cytoplasmic lesions; (2) 2.5 to 20 hrs where nuclear repair mechanisms are active; (3) larval stages (24 to 72 hrs) where the sensitivity varies in the different strains studied. Males and females are equally sensitive to uv light when irradiated between 1 and 20 hrs after oviposition. When hatching larvae (24 hrs) are irradiated, males are much more sensitive than females, only in cases where there is a difference in recombination frequency between them (D. melanogaster, Oregon R strain, uv sensitive strain, and a strain carrying the mutator gene). In strains where males enjoy normal levels of recombination (D. ananassae wild type and Susuki's strain) no difference in sensitivity can be detected throughout development. The same is true for strains carrying mutations that abolish or reduce meiotic recombination in females (c3G and sbd^{105}) where males are even more resistant than the females. These results show a very close correlation between dark repair and meiotic recombination ability. Nuclease activities were detected at various pHs in different tissues. No difference can be observed between the nuclease pattern of male D. melanogaster or D. ananassae. These results and the fact that ovaries and testis of D. melanogaster have a similar set of nucleases suggest that the lack of recombination in D. melanogaster males might be due to the repression of recombinational enzymes in vivo. In these strains of flies, the nuclease activity of relative electrophoretic mobility 0.56 is reduced to half the level encountered in the wild type. A uv-sensitive stock shows the same

decrease in nuclease activity. These results led to the conclusion that the nuclease having a relative electrophoretic mobility of 0.56 is a recombinational enzyme and participates also in dark repair. This nuclease would be either coded by a gene located in region 58 on the right arm of chromosome III or by a gene located on the second chromosome. (Diss. Abstr.)

Radionuclide Effects (Internal Source)

18532 (STI/PUB-319) SAFE HANDLING OF RADIONUCLIDES. Safety Series No. 1 (1973 Edition). (International Atomic Energy Agency, Vienna (Austria)). Mar 1973. 99p. IAEA $4.00.

This manual provides information for the guidance of personnel in the safe handling of radionuclides. Data on the maximum permissible limits for external and internal exposure to various radionuclides are reviewed. Methods are described for: the organization of a radiation safety program; medical supervision of personnel; personnel and area monitoring; handling, storage, and transportation of sealed and unsealed sources; the decontamination of surfaces and equipment and of personnel in the event of external or internal contamination; the disposal of radioactive wastes; and emergency procedures in the event of accidents that might result in external or internal contamination. (CH)

Man

Refer also to abstracts 18461 and 18463.

18533 (AWTSC-4) STRONTIUM-90 AND CAESIUM-137 IN THE AUSTRALIAN ENVIRONMENT DURING 1970 AND SOME RESULTS FOR 19[illegible]. (Atomic Weapons Tests Safety Committee, Victoria (Australia)). Sep 1972. 45p. Dep. NTIS (U. S. Sales Only) $4.25.

Results of measurements are reported for ^{137}Cs and ^{90}Sr in fallout in Australia during 1970 and 1971. The measurements were part of a survey of the Australian environment that has been in progress since 1957. The radioisotopes are from nuclear weapons tests and were monitored in fallout deposition from the atmosphere, in key foodstuffs, and in representative members of the population. Any biological effect of ^{90}Sr on individuals within the population would arise from the radiation doses it delivers to bone tissue in which it may have been incorporated after ingestion in foodstuffs. During 1970 and 1971 these radiation doses to Australians corresponded to less than 4% of the average annual background radiation dose from natural sources. The most important effect of ^{137}Cs relates to the whole population exposed rather than to the individual. This is because the effect arises from irradiation of the reproductive cells and potentially affects the hereditary material. During 1970 and 1971 these radiation doses to Australians, due to ^{137}Cs both in their bodies and in the environment, corresponded to less than 1% of the average annual background radiation dose from natural sources. These radiation doses to the bone tissue and to the genetic material of the population take account of strontium 90 and ^{137}Cs in fallout over Australia up to the end of 1971 from all nuclear weapons tests in both the northern and the southern hemispheres. (auth)

18534 (AWTSC-5) FALLOUT OVER AUSTRALIA FROM NUCLEAR WEAPONS TESTED BY FRANCE IN POLYNESIA DURING JUNE AND JULY 1972. (Atomic Weapons Tests Safety Committee, Victoria (Australia)). Oct 1972. 25p. Dep. NTIS (U. S. Sales Only) $3.25.

Fresh fission products were identified in fallout over Australia during July, August, and September, 1972, following the explosion of three low yield nuclear devices by France in Polynesia. Measurements at 26 stations to determine whole-body radiation doses from this fresh fallout and at nine major centers of population to establish average doses to thyroid arising from iodine-131 in milk supplies are reported. Although clearly identified by the measurements, the fresh fission products were present in the Australian environment at extremely low levels of radioactivity. Thus the highest whole-body dose from the fallout corresponds to less than 0.2% of the average annual background radiation dose from natural sources. There was little, if any, contamination of milk supplies with iodine-131 and the highest thyroid dose was less than 0.3% of the level considered acceptable by the National Radiation Advisory Committee. (auth)

18535 (CONF-720505-, pp 254-277) EPIDEMIOLOGICAL STUDIES OF FALLOUT AND PATTERNS OF CANCER MORTALITY. Sternglass, E. J. (Univ. of Pittsburgh). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

The hypothesis of a causal connection between radionuclide concentration in the environment and cancer mortality in man was investigated by analyzing data on cancer mortality in Japan and the United States. The hypothesis was supported by the following findings: the largest increases in cancer mortality took place in those types of organs known from animal studies to concentrate the dominant short-lived rare-earth and alkaline-earth nuclides most strongly, namely, the pancreas, the bone marrow, the lung, the prostate, and the female reproductive organs; the rises and declines occurred with time delays of 3 to 7 years, corresponding to the known latency periods for leukemia and most other types of cancers; a dose–response relationship was found to hold for cervical cancer and the concentration of short-lived beta-emitting radionuclides in the milk similar to that found earlier for leukemia; the absolute magnitude of the changes in cervical-cancer mortality per unit of activity in the milk were found to be of the same order as previously observed for leukemia in the most sensitive members of the general population, namely, the early embryo and people over 65 years of age; the same synergistic effects of dust, cigarette smoke, and chemical air pollution already observed for uranium miners and in animal studies were found to affect the mortality rates from respiratory cancers for the general population; and a decreasing trend in mortality rates for certain cancers, such as cancer of the uterus, was shown to be attributable to increasingly successful early detection and treatment since the incidence rate of cervical cancer showed a rising trend during the period of increasing radionuclide concentration in the environment. As with leukemia, the glandular, reproductive, and respiratory system cancers in man show no evidence of any threshold or significant dose-rate effects at the low levels of diagnostic and environmental radiation. (auth)

18536 (CONF-720505-, pp 347-357) SCALING DOSE, TIME, AND INCIDENCE OF RADIUM-INDUCED OSTEOSARCOMAS OF MICE AND DOGS TO MAN. Goldman, M. (Univ. of California, Davis); Rosenblatt, L. S.; Hetherington, N. W.; Finkel, M. P. Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Extrapolation to man of radionuclide toxicity data from animals is usually based on some relationship between rad dose and the number of exposed animals manifesting the end point (e.g., cancer). Safety factors based on life-span, weight, species-dependent temporal and spatial dose patterns, and magnitude of effect (multiple tumors) lead to varying assessments of risk for the same radionuclide. Animal data have been used to construct three-dimensional response surfaces (dose–time–effect) as a base for determining some relationships between relevant parameters. Data used were from the ^{226}Ra mouse study at Argonne and the beagle studies at Salt Lake City and Davis, in which exposures began at about 8% of the life-span. As in man the major life-shortening event in the studies is osteosarcoma induction. The cumulative incidence rates of osteosarcoma deaths, computed from age-specific incidence rates in each dosage category, were used to derive dose–time–effect response surfaces to which each individual contributed and from which extrapolations can be made. Dogs required about 40% less microcuries per kilogram injected than did mice for cumulative sarcoma incidence in the range between 10 and 90%. For example, 50% cumulative tumor incidence was estimated in dogs and mice following ~0.38 μCi/kg injected and 0.66 μCi/kg injected, respectively ($0.38/0.66 \simeq 0.6$). Relative to life-span, mouse tumors appeared to start later than dog tumors. At 10 μCi/kg injected, within 2.2 years (13% life-span) the fitted cumulative incidence in dogs increased from 2 to 98%; in mice the same incidence occurred in 1.6 years, or 49% of life-span. The species-dependent retention and dosimetric patterns for ^{226}Ra suggest a 1.5-fold higher mean skeletal dose rate in dogs than in mice. Thus, for equal dose rates, oncogenicity in both species is quite close and provides one basis of scaling dose rate, time, and effect between animals and man. (auth)

18537 (CONF-720505-, pp 406-420) PRELIMINARY COMPARISON OF THE CARCINOGENICITY OF ^{226}Ra AND ^{228}Ra IN MAN. Rowland, R. E.; Keane, A. T.; Lucas, H. F. Jr. (Argonne National Lab., IL). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Radium is the only bone-seeking radioisotope for which sufficient human data now exist to allow the postulation of dose–response relationships for neoplasm induction. The American radium population actually contains cases exposed to either essentially pure ^{226}Ra or to a mixture of ^{226}Ra and ^{228}Ra; thus it is possible to determine from this population dose–response relationships for the two radioisotopes. These dose–response relationships do not indicate any significant difference in the

toxicity of ^{228}Ra vs. ^{226}Ra, although it is observed that the occurrence of sarcomas is greater in the population exposed to ^{228}Ra. Since a difference in the toxicity of these two radioisotopes was observed in studies with beagles, there is some doubt that toxicity ratios observed in beagles can be employed directly to predict toxicity ratios in man. (auth)

18538 (CONF-720505-, pp 421-436) EFFECT OF THE REMODELLING OF BONE UPON THE RELATIVE TOXICITIES OF RADIUM AND PLUTONIUM IN MAN AND DOG. Marshall, J. H.; Lloyd, E. (Argonne National Lab., IL). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

When the rates of bone formation and resorption are high, monomeric plutonium does not remain for long on bone surfaces. Dogs injected with radioisotopes at little over one year of age (as in the Salt Lake Project) have bone turnover rates that exceed those in adult man by at least an order of magnitude. Therefore, the skeletal toxicity of monomeric plutonium relative to radium in man may be significantly larger than that in the experimental dogs. The probable magnitude of this effect is estimated by constructing expressions for the dose rate to bone surface from ^{239}Pu and ^{226}Ra as a function of time since injection and as a function of the remodelling rate of bone. Skeletal plutonium is assumed to be initially deposited on bone surfaces; as time from injection increases, this initial deposit is displaced from bone surface by resorption and by burial due to new bone formation, eventually approaching a volume distribution. On the other hand, radium is treated as a volume distribution throughout. The relative biological effectiveness (RBE) of plutonium vs. radium in either man or dog is then assumed to be the ratio of the average skeletal dose from radium to that from plutonium under the condition that the doses to bone surface within the mean induction time of osteosarcomas are equal. Using best estimates of the parameter values from existing literature and taking RBE (Pu/Ra) = 6 for the Salt Lake dogs, the model leads to an estimate for RBE (Pu/Ra) in man of 17 ± 6, about three times that in the dogs. The need for more data concerning this probable effect is emphasized. (auth)

18539 (CONF-720505-, pp 437-450) PROTRACTION EFFECT ON BONE-SARCOMA INDUCTION OF ^{224}Ra IN CHILDREN AND ADULTS. Spiess, H.; Mays, C. W. (Univ. of Utah, Salt Lake City). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Shortly after World War II a series of about 2000 German children and adults were given repeated injections of ^{224}Ra (3.62-day half-life) for the intended treatment of tuberculosis, ankylosing spondylitis, and other diseases. As a consequence, bone sarcomas were induced in 53 of the 897 subjects for whom recent status is known. At 20 years after the first injection of ^{224}Ra, the effectiveness (percent incidence of bone sarcomas per 100 rads average skeletal dose) for an injection span of m months could be expressed as: $E_J = (0.4\%/100\text{ rads}) + (1.8\%/100\text{ rads})(1 - e^{-0.09m})$; $E_A = (0.3\%/100\text{ rads}) + (1.4\%/100\text{ rads})(1 - e^{-0.09m})$, where E_J and E_A represent the effectiveness in juveniles and adults, respectively. For a fixed total dose, the observed incidence was higher at longer protraction of the alpha-particle irradiation. Initially this finding came as a surprise because with radiations of low linear energy transfer (x rays, gamma rays, and beta particles) the effects from a given dose are usually much less when the dose rate is low and the irradiation period is extended. Plausible reasons for the higher incidence when the alpha irradiation is protracted, rather than abrupt, are increased numbers of irradiated cells, less subsequent killing of premalignant cells, and prolonged stimulus for cell division. (auth)

18540 (CONF-720505-, pp 451-464) HUMAN LEUKEMIC RISK DATA DERIVED FROM PORTUGUESE THOROTRAST EXPERIENCE. Abbatt, J. D. (Department of National Health and Welfare, Ottawa, Can.). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972.

In radionuclide carcinogenesis.

Thorium dioxide containing ^{232}Th in colloid solution injected for radioactive contrast purposes was widely used throughout the world up to 1945. The Portuguese population of 2428 individuals who had been injected between 1930 and 1955 with such a solution for radiographic purposes was identified and traced together with an approximately matched control population. This population and its fate were reviewed up to the end of Dec. 31, 1970, and more adequate risk data are now available. They indicate that in the population investigated the risk of developing an acute fatal blood dyscrasia following the systemic injection of Thorotrast is a 12- to 16-fold increase in risk over the natural risk of developing such diseases. This is to be compared with a 6- to 8-fold increase over the natural risk of developing leukemia in therapeutically irradiated ankylosing spondylitics. Portuguese data are of particular interest because, in addition to providing risk data, they also provide evidence that under the conditions of irradiation obtaining in this population the period between the injection of the Thorotrast and the development of frank symptoms and signs of leukemia is very long. In the Thorotrast patients this period is about 20 years, which may be compared with a 5- to 7-year period observed in the ankylosing spondylitics and Japanese bomb survivors. The incidence of lung cancer is not markedly elevated, and the incidence of osteogenic sarcomas is only slightly elevated over the expected incidence. This latter observation is at variance with a number of predictions made in the past. In addition to data on the acute fatal blood dyscrasias and those types already mentioned, there is a wealth of information now available on the induction of fatal primary mesenchymal tumors, particularly hemangioendotheliomas of the liver and spleen. This information is reviewed briefly. (CH)

18541 (CONF-720505-, pp 465-474) PRELIMINARY AUTOPSY FINDINGS IN U. S. TRANSURANIUM REGISTRY CASES. Norwood, W. D. (Hanford Environmental Health Foundation, Richland, WA); Norcross, J. A.; Newton, C. E. Jr.; Hylton, D. B.; Lagerquist, C. Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

The first 14 autopsies on Pu personnel presented to the Registry serve to indicate areas of differences between organ depositions determined by calculations or in vivo radiation measurements made before death and extrapolations from measured deposition in organ samples. They also show some marked differences in the concentration of ^{239}Pu in different areas of an organ, emphasizing the need for large samples or whole organs. In one autopsy 92% of the total lung deposit was found in pleura and subpleural lung parenchyma. Studies are in progress to determine more accurately the deposition in pleura, lung parenchyma, and lymph nodes in the chest. In one autopsy the concentration of the ^{239}Pu in vertebrae was 3.5 times that in the rib. In several other cases the difference between the concentration in rib and that in sternum has varied from 2 to 30, the concentration in ribs being higher in some cases and lower in others. Whole bodies will be studied to help determine the best organ samples to use in extrapolating total organ deposition from a measured sample. Perhaps greater emphasis should be placed on maximum concentration in organs rather than on total organ burden, which is presently used in setting permissible organ limits. Pertinent health physics and medical data for the 14 cases are tabulated. (auth)

18542 (CONF-720505-, pp 475-486) COMPARISON OF BONE TUMOR SITES IN BEAGLES CONTINUALLY FED ^{90}Sr OR INJECTED WITH ^{226}Ra AS A MEANS OF SCALING RISK TO HUMANS. Pool, R. R.; Williams, J. R.; Goldman, M.; Rosenblatt, L. (Univ. of California, Davis). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

Ninety primary-bone sarcomas (PBS) were induced in 74 beagles that either ingested ^{90}Sr from fetal life (22 tumors in 15 dogs) or were injected with ^{226}Ra (68 tumors in 59 dogs). At the highest ^{90}Sr level (~36 μCi/day, maximum dose rate ~20,000 mrad/day), 10 of 19 beagles initially at risk developed 17 PBS, which occurred preponderantly in the appendicular skeleton (1.5 to 3 years of age). At the ~12 μCi/day level, 3 of 47 developed jaw sarcomas (6 to 7 years of age); and at the ~4 μCi/day level, 2 of 56 developed maxillary sarcomas (7 to 8 years of age). No PBS have developed in 160 controls or in 251 comparable dogs fed at lower ^{90}Sr levels. Following eight injections of ^{226}Ra (14.5 to 18 months of age), 24 PBS developed at the highest level (10 μCi/kg) in 20 of 38 dogs (3.8 to 5.6 years of age, ~15,000 cumulative rads). At the 3.33 μCi/kg level, 31 of 41 dogs developed 35 PBS (3.9 to 7.2 years of age, ~4500 cumulative rads), and at the lowest tumor-producing level (1.11 μCi/kg), 8 of 39 beagles have developed 9 PBS (5.5 to 7.5 years of age, ~1900 cumulative rads). Compared with spontaneous PBS in other breeds of dogs, the sites of radionuclide-induced PBS differed; incidence by site was not enhanced by radiation, a fact that agrees with observations relative to ^{226}Ra exposure in man. Axial-to-appendicular ratios for PBS in the dog were spontaneous, 20 : 80; ^{90}Sr, 40 : 60; and ^{226}Ra, 30 : 70. In many instances, the incidence of PBS in particular bones, e.g., humeri, was not greatly altered by irradiation, but the sites within the bone were altered. For example, 14% of the spontaneous cases were in the proximal and 1% in the distal humeri; in dogs fed ^{90}Sr the incidence was 0 to 23%, respectively. However, marked increases in PBS were noted in mandible, pelvis, and vertebral column; and marked de-

creases were noted in the radius. The distribution of sites was dose dependent among dogs fed ^{90}Sr but not among dogs injected with ^{226}Ra. Limb involvement predominated among ^{90}Sr dogs at the highest dose level; at lower levels tumors were confined to the head. The ^{90}Sr data suggest that temporal, spatial, and morphologic tumor patterns may be functions of dose rate and degree of cellular repair, which, in turn, are dependent upon the severity of prior (irradiation) injury. (auth)

18543 (CONF-730814-1) PHYSICAL DOSIMETRY INVOLVED IN MAKING DOSE ESTIMATES FOR POPULATION EXPOSURES. Snyder, W. S. (Oak Ridge National Lab., Tenn.). 1973. 28p. Dep. NTIS $3.50.

From 2nd international summer school on radiation protection; Herceg Novi, Yugoslavia (21 Aug 1973).

Careful assessment of the internal radiation dose or dose rate from deposited radioisotopes in the human population must take into account the physical factors relevant to body dimensions and organ mass of the various individuals comprising the population. Tabulations of radiation dose to target organs from radionuclides in source organs, based on computer analysis of radionuclide decay data, are all calculated for adults. Modifications for use in estimating radiation dose and dose rate for infants and children are described. (CH)

18544 (NP-19817) PHYSICAL ASPECTS OF THE EFFECTS OF NUCLEAR REACTORS IN WORKING AND PUBLIC ENVIRONMENTS. Clarke, R. H. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1973. 282p. Dep. NTIS (U. S. Sales Only) $16.25.

Thesis. Submitted to Polytechnic, London (England).

The radiation doses in various body organs of individuals exposed to releases of radioactivity from nuclear installations are evaluated. A number of mathematical models have been evolved to represent each stage under normal operational or accident conditions from irradiated nuclear fuel to man. Comprehensive computer programs have been developed for predicting the isotopic content of the fuel. Leakage of radioactive nuclides from the fuel to the atmosphere is calculated and after allowing for the meteorological behavior of the effluent, the complete radioactive environment may be specified. The final stage of the calculation is the interaction between this radiation and man. Computer models deal with the internal and external dosimetry problem. (UK)

18545 LATE EFFECTS OF THOROTRAST ADMINISTERED 21 TO 27 YEARS BEFORE. Clinical Study on 44 Patients. Nozue, Y. (Yokohama City Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi; 32: No. 5, 436-475(Aug 1972). (In Japanese).

The late effects of thorium deposition in human beings were studied using 44 individuals who were intravenously injected with Thorotrast 21 to 27 yrs ago and 37 individuals as controls. Shadows on x-ray film corresponding with the Thorotrast deposits were observed in 95% of Thorotrast-administered group. Shadows of upper abdominal lymph nodes were observed in the cases given above 8 ml, and the shadows of the liver and spleen in the cases given above 25 ml of Thorotrast. Tissue radiation doses were 0.36 to 1.51 rad per week in the liver, and 0.39 to 2.68 rad per week in the spleen, in regard to the cases that were given Thorotrast of between 8 to 36 ml. On examination of the liver function, the disturbance of protein metabolism was significantly observed in the Thorotrast-administered group; decrease of the level of serum albumin and increase of that of globulin, especially α- and β-globulin. The slow down of removal rate of serum protein was also significantly observed in the same group. By blood examination, the count of red blood cell, white blood cell, and blood platelet decreased significantly in the Thorotrast-administered group. In the histopathological study of the liver, Thorotrast granules were deposited resulting in extensive parenchymal cell destruction with fibrosis. Histological studies of the spleen, in all cases, showed structural destruction and fibrosis of the red pulp in association with multiple depositions of Thorotrast granules in the reticulum cells. The regional lymph nodes of the liver and spleen hilus revealed also severe fibrosis resulting from massive deposition of Thorotrast granules. Nineteen cases of Thorotrastoma at the injection site were found in Thorotrast-administered group. Among these, three cases showed clinical symptoms including regional pain. (auth)

Animals

18546 (AEC-tr-7430, pp 161-166) EARLY CHANGES IN CERTAIN IMMUNOLOGICAL INDICES IN THE CASE OF PLUTONIUM-239 LESION OF EXPERIMENTAL ANIMALS. Shubik, V. M.; Fedorova, A. V.; Borisova, V. V. (Leningrad Scientific Research Inst. of Radiation Hygiene). Translated from Radiobiologiya; 13: No. 1, 119-123(1973).

The indices of nonspecific immunity and the formation of complement-fixing autoantibodies in noninbred white rats, treated once perorally with 20 μCi of ^{239}Pu or 2 μCi intravenously, were studied. The peculiarities of the distribution and formation of the dose in the case of various modes of plutonium administration determined the differences in the changes in the immunological responses studied. (tr-auth)

18547 (CONF-720505-) RADIONUCLIDE CARCINOGENESIS. Proceedings of the Twelfth Annual Hanford Biology Symposium, May 10-12, 1972. AEC Symposium Series. Sanders, C. L.; Busch, R. H.; Ballou, J. E.; Mahlum, D. D. (eds.). (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1973. 506p. Dep. NTIS $13.60.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

Separate abstracts were prepared for 28 of the 33 papers presented at this conference. Abstracts of five papers appeared in NSA previously as numbers 26: 34422, 45819, 45895, 45910, and 28: 11082. (CH)

For abstracts of individual papers see: 18463, 18512-18514, 18535-18542, and 18548-18563.

18548 (CONF-720505-, pp 25-32) EFFECT OF AGE ON THE CARCINOGENICITY OF ^{131}I IN THE RAT. Interim Report. Sikov, M. R.; Mahlum, D. D.; Clarke, W. J. (Battelle Pacific Northwest Labs., Richland, WA). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

The role of age in radioinduced thyroid carcinogenesis was studied by exposing groups of 50 prenatal, newborn, weanling, and adult rats on 5 consecutive days to one of three levels of ^{131}I. Control animals were given a control solution and kept until death or 30 months of age. Additional animals were injected and sacrificed for radioanalysis and radiation-dose calculations. The study was performed as several complete replicates; the results for the initial one-half of the animals are reported here. There were a number of thyroid tumors in the control animals of the newborn and prenatal groups, but none were found in the adult or weanling controls. The incidence of tumors among the newborn and prenatal animals exposed to the low and medium doses did not exceed that of the controls. Those exposed to the high dose neonatally had a decreased incidence, whereas those exposed prenatally showed a statistically significant elevation. The incidence of thyroid tumors was markedly elevated in adults exposed to the low dose with a lesser incidence in the two higher dose groups. In the weanlings tumor incidence was greatest at medium dose, with lower incidences in the low- and high-dose groups. Marked gross and histologic pathology, as well as tumors, was noted in several of the pituitaries from animals of all age-dose groups; this does not appear to be related to the exposure. (auth)

18549 (CONF-720505-, pp 33-43) RADIATION-INDUCED NEOPLASIA AND IMPAIRMENT OF EPITHELIAL REGENERATION, TWO ANTAGONISTIC EFFECTS. Walinder, G. (Research Inst. of Swedish National Defence, Sundbyberg). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Quantitative methods were elaborated for determining cell number, cellular survival, and relative occurrence of various tissue components in the thyroid gland of the CBA mouse. By means of these methods, it was shown that there is a radiation-induced suppression in size and function of the thyroid gland in the mouse following injection of ^{131}I or whole-body x irradiation caused by an impairment of the long-term regeneration of the epithelial cells. Since a radiation-induced decrease in thyroid size and function can be seen in most mammalian species (including man), the sensitivity of the epithelial long-term regeneration to radiation is probably a general phenomenon. The development of initial radiation damage in the thyroid tissue into macroscopic tumors was shown to be highly promoted by the proliferative activity of the epithelial cells in the gland. This observation in mice was confirmed by several investigations in other animals. The inhibition of epithelial regeneration by radiation thus obviously counteracts the development of neoplasia in the gland. With the exception of the Long Evans rat and the CBA mouse, there have been no well-documented cases of thyroid carcinoma in animals or in man resulting from single exposures to ^{131}I. It is suggested that this is a consequence of the interference with epithelial regeneration. The two exceptions to the rule (Long Evans rat and CBA mouse) are discussed with reference to the special type of thyroid growth that is characteristic for these strains. (auth)

18550 (CONF-720505-, pp 119-137) FACTORS INFLUENCING THE INDUCTION OF LUNG CANCER IN HAMSTERS BY IN-

TRATRACHEAL ADMINISTRATION OF ^{210}Po. Little, J. B.; Grossman, B. N.; O'Toole, W. F. (Harvard Univ., Boston). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Polonium-210 was administered by 7 or 15 weekly intratracheal instillations to Syrian golden hamsters. When ^{210}Po was given adsorbed onto hematite carrier particles, malignant lung tumors occurred in 47 to 91% of hamsters receiving total lung doses of 300 to 5000 rads. These tumors were nearly all mixed epidermoid and adenocarcinomas apparently arising from the peripheral airways. The tumor-induction time, as well as incidence, was related to dose. Hematite was not carcinogenic by itself but appeared to have a slight potentiating effect on ^{210}Po carcinogenesis. Autoradiographic studies showed that, following administration bound to hematite particles, ^{210}Po remained associated with visible hematite deposits in the lung, leading to a nonuniform distribution of radiation dose. Polonium-210 administered alone in saline gave rise to a much more uniform dose distribution and was more carcinogenic than ^{210}Po administered on particles. These results suggest that, in the dose range studied, alpha radiation is more effective in producing lung cancer when a lower but relatively uniform dose is delivered to a large volume of lung tissue than when a similar amount of radioactivity is distributed such that much higher radiation doses are delivered to relatively small tissue volumes. (auth)

18551 (CONF-720505-, pp 138-153) COCARCINOGENESIS OF $^{239}PuO_2$ WITH CHRYSOTILE ASBESTOS OR BENZPYRENE IN THE RAT ABDOMINAL CAVITY. Sanders, C. L. (Battelle Pacific Northwest Labs., Richland, WA). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Studies were made of the carcinogenic response of intra-abdominally injected $^{239}PuO_2$ at several doses and the cocarcinogenic response to combinations of $^{239}PuO_2$ with 3,4-benzpyrene (BP) or chrysotile asbestos. Groups of 18 to 36 female rats were given an intra-abdominal injection of 70 to 360 or 2880 nCi of $^{239}PuO_2$ particles, 720 nCi of $^{239}PuO_2$ with 15 mg of asbestos, 360 nCi of $^{239}PuO_2$ with 5 mg of BP, 15 mg of asbestos, or 5 mg of BP alone. Control rats received an injection of saline or were untreated. The asbestos fibers and PuO_2 were concentrated within fibrous adhesions of the visceral peritoneum, mostly in the omentum. The PuO_2 was also concentrated within parasternal lymph nodes, although no tumors were derived from these high-radiation dose areas. Benzpyrene increased the translocation of ^{239}Pu to liver and lung; asbestos had no influence on ^{239}Pu distribution. Both abdominal sarcomas and mesotheliomas were induced by $^{239}PuO_2$ or asbestos. No mesotheliomas were found in rats given BP only. About 90% of all abdominal tumors originated in the omentum. Observed tumor incidences following $^{239}PuO_2$ were a 26% incidence of mesotheliomas and a 38% incidence of sarcomas at a calculated average dose of 33,500 rads to omental tissue, a 10% mesothelioma incidence and a 21% sarcoma incidence at 6300 rads, and a 6% mesothelioma incidence and a 14% sarcoma incidence at 770 rads. Asbestos acted in an additive manner with $^{239}PuO_2$ in inducing mesotheliomas, the two agents combined having an effect equal to the sum of their effects when administered separately. A similar additive response was seen with BP and $^{239}PuO_2$ in the induction of abdominal sarcomas. Our results suggest that radiation-protection considerations for plutonium should involve the distribution of radiation dose within the target tissue as well as evaluation of exposures to other industrial pollutants. (auth)

18552 (CONF-720505-, pp 154-158) CARCINOGENIC EFFECT IN BONE OF RADIOSTRONTIUM AND ESTROGENIC HORMONES. Nilsson, A.; Roennbaeck, C. (Research Inst. of the Swedish National Defence, Sundbyberg). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

In mice estrogenic hormones caused an intense apposition of endosteal bone, probably because of an increasing formation of new bone cells from primitive cells in the marrow. It was therefore anticipated that estrogenic hormones might considerably influence (possibly enhance) the carcinogenic effect of ^{90}Sr. Groups of male and female CBA mice were treated with estrogenic hormone alone, ^{90}Sr alone, or estrogen + ^{90}Sr. Estradurin, an estrogen of long duration, was given subcutaneously in monthly doses between 1.0 to 0.25 mg per mouse for 3 consecutive months. Strontium-90 in the form of $^{90}Sr(NO_3)_2$ was administered intraperitoneally either 7 days after the first or the last injection of estrogen. The doses were 0.8 or 0.4 μCi per gram of body weight. Among the males given both estrogen and ^{90}Sr, there was a mean number of 4.2 bone tumors per mouse with a mean induction time of 194.1 ± 2.6 days as compared with 2.3 among those given only ^{90}Sr. The mean induction time for the latter was 316.1 ± 1.1 days. The female mice treated with ^{90}Sr + estrogen had 4.1 bone tumors/mouse, and those given only ^{90}Sr, 2.0. The induction times were 251.0 ± 4.1 and 379.3 ± 9.7 days, respectively. No bone tumors were found in the group of mice treated with only estrogen. The tumor histology was also modified. Osteoclastic and mixed osteosarcomas were thus frequent in combination-treated groups in contrast to what is seen when ^{90}Sr was given alone. Several parameters including histology, immunologic competence, and radiation-dose patterns have to be considered in an attempt to explain the increased tumor incidence found in animals treated with both ^{90}Sr and estrogen. It appears that the destruction by ^{90}Sr and the stimulation by estrogen of bone cells are important factors. The tumorigenic process is probably also further enhanced by the depressing action of ^{90}Sr and estrogen on the immunologic system. (auth)

18553 (CONF-720505-, pp 159-167) HEPATIC TUMOR DEVELOPMENT IN RATS EXPOSED TO ^{144}Ce AND DIMETHYLAMINOAZOBENZENE. Mahlum, D. D. (Battelle Pacific Northwest Labs., Richland, WA). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

The effect of the administration of the liver-seeking radionuclide, ^{144}Ce, on the induction of liver tumors by dimethylaminoazobenzene (DAB) was studied under a variety of conditions. The relationship between irradiation of the liver by ^{144}Ce and the induction of tumors by DAB was found to be complex, the results depending on the sex of the animal, the temporal relationship between DAB and ^{144}Ce administration, the composition of the diet, and the radionuclide dose. The female rat was found to be more sensitive than the male to the oncogenic effects of DAB. Moreover, ^{144}Ce injected prior to initiation of DAB tended to increase the incidence of hepatic tumors in the female but not in the males. There was a suggestion, however, that ^{144}Ce given 2 or 4 weeks after beginning DAB feeding increased the tumor incidence in males. The changes were relatively small, and large numbers of animals were required to detect an effect in either sex. It was shown that 0.06% in the diet was more effective than the 0.09% level. DAB altered the metabolism of ^{144}Ce by decreasing the biliary excretion of the radionuclide. The result was an enhanced retention by the liver. (auth)

18554 (CONF-720505-, pp 168-180) CARCINOGENIC EFFECTS OF ^{210}Po IN DOGS TREATED BY OXATHIOL. Lebedev, B. I.; Lebedeva, G. A.; Parfenov, Y. D. (Institute of Biophysics, Moscow). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

The carcinogenic effect in 25 male dogs was studied over a period of 12 years following a single subcutaneous injection of ^{210}Po at dose of 2.5 μCi/kg and administration of oxathiol to accelerate elimination of ^{210}Po from the body. Sixty eight cases of neoplasms were found in 20 dogs that survived 6 years after injection of ^{210}Po. Cumulative incidence of tumors toward the 12th year of observation was 2.7 tumors per animal. The maximum tumor incidence of 4.6 tumors was observed 9 years after injection of ^{210}Po. The highest incidence of tumors (in 70% of dogs with tumors) was observed in the liver (hepatomas), in the adrenals (adenomas in cortical layer and one pheochromocytoma), and in the testes (leidig-cell tumors). In addition, tumors developed in the kidneys, in the exocrine pancreas, and in the thyroid. There were single cases of tumor in the urine bladder, subcutaneous tissue, cutaneous tissue, the skeleton, and parathyroid. Malignant neoplasms comprised 26.5% of the total number of tumors. The greatest number of malignant tumors occurred in the liver. (auth)

18555 (CONF-720505-, pp 181-200) NEOPLASIA IN BEAGLE DOGS AFTER INHALATION OF $^{144}CeCl_3$. Benjamin, S. A.; Boecker, B. B.; Chiffelle, T. L.; Hahn, F. F.; Hobbs, C. H.; Jones, R. K.; McClellan, R. O.; Pickrell, J. A.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Beagle dogs were exposed to an aerosol of $^{144}CeCl_3$ to evaluate the long-term biological consequences. Tissue distribution studies in a group of serially sacrificed dogs indicated that ^{144}Ce inhaled in this form was translocated at a moderately rapid rate from lung to liver and skeleton leading to significant radiation doses to all three tissues. Fifty-five dogs that received initial lung burdens ranging from 20 to 2900 μCi and 15 control dogs were

held for life-span observation. To date, 22 dogs have died or been euthanized with a variety of pathological changes related to one or more of the irradiated tissues. Eight dogs died at relatively early times postinhalation exposure with severe bone-marrow damage, and seven died at intermediate times with radiation pneumonitis, hepatic necrosis, or bone-marrow aplasia. Seven dogs died at relatively late times postinhalation exposure (799 to 2164 days), and six of these had at least one type of neoplasm. The neoplasms included one hemangiosarcoma of the liver, one osteosarcoma, two myelogenous leukemias, one pulmonary adenoma, and two squamous-cell carcinomas involving the maxilla. In addition, one animal had a nonneoplastic process, myelofibrosis with myeloid metaplasia, which probably relates to radiation-induced bone-marrow damage. The radiation doses in these seven animals ranged from 6600 to 52,000 rads to the liver, 950 to 8300 rads to the skeleton, and 950 to 9500 rads to the lung. Thirty-three ^{144}Ce-exposed dogs and all the control dogs are surviving at approximately 6 years postinhalation exposure. (auth)

18556 (CONF-720505-, pp 201-214) INDUCTION OF PULMONARY NEOPLASIA IN BEAGLE DOGS BY INHALED ^{144}Ce FUSED-CLAY PARTICLES. Hahn, F. F.; Benjamin, S. A.; Boecker, B. B.; Chiffelle, T. L.; Hobbs, C. H.; Jones, R. K.; McClellan, R. O.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

To determine the biologic effects of a relatively insoluble form of inhaled ^{144}Ce, 111 beagle dogs were exposed to various levels of ^{144}Ce in fused-clay aerosols. The resulting initial lung burdens (ILB) ranged from 0.023 to 2100 μCi. Fifteen dogs were exposed to nonradioactive fused clay and served as controls. To date, 15 dogs have died 142 to 410 days after inhalation exposure as a result of radiation pneumonitis and pulmonary fibrosis. Five dogs died from primary pulmonary neoplasms 750 to 1318 days postinhalation exposure with calculated pulmonary radiation doses to death ranging from 23,000 to 48,000 rads. Pulmonary hemangiosarcomas were found in all five dogs, and in some cases distant metastases had occurred. In addition, one dog had a pulmonary fibrosarcoma and another had a bronchiolo-alveolar carcinoma, both of which metastasized to the tracheobronchial lymph nodes. Only three dogs with similar ILB's have died without pulmonary neoplasms but did so at earlier times, 186, 193, and 410 days postinhalation exposure with pulmonary-radiation doses of 38,000, 19,000, and 44,000 rads, respectively. Ninety-one ^{144}Ce-exposed dogs and all the controls are surviving at 239 to 1565 days postinhalation exposure including 44 that have survived longer than 750 days with cumulative radiation doses to lung ranging from 2 to 36,000 rads. These findings will be related to other instances of radiation-induced pulmonary neoplasia. (auth)

18557 (CONF-720505-, pp 215-232) NEOPLASMS IN DOGS THAT INHALED $^{90}SrCl_2$. McClellan, R. O.; Benjamin, S. A.; Boecker, B. B.; Chiffelle, T. L.; Hobbs, C. H.; Jones, R. K.; Pickrell, J. A.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

The effects of inhaled $^{90}SrCl_2$ in the beagle dog have been investigated. Seventy-two dogs were exposed to aerosols containing ^{90}Sr, resulting in initial body burdens ranging from 2.6 to 280 μCi of ^{90}Sr/kg. The long-term retained burdens in these animals ranged from 1 to 120 μCi of ^{90}Sr/kg. Two of these dogs were sacrificed at 5 days, 2 at 1 month, and 2 at 1 year after inhalation of ^{90}Sr for histopathologic and other studies. To date, 33 ^{90}Sr dogs have died or have been euthanized, 6 during the first 31 days after inhalation of ^{90}Sr (with pancytopenia and marked destruction of marrow cellular elements) and 27 between 585 days and 2628 days postexposure. The latter group includes 11 dogs with hemangiosarcomas, 3 with fibrosarcomas, 9 with osteosarcomas, 2 with osteochondrosarcomas, 1 with osteochondrofibrosarcoma, 1 with leukemia, and 1 with baso-squamous carcinoma (4 dogs had both a hemangiosarcoma and an osteosarcoma). The skeletons of these dogs received initial radiation dose rates of 7.1 to 55 rads/day and cumulative doses to death of 4000 to 22,000 rads. An additional three ^{90}Sr dogs died with nonneoplastic diseases, 1 with an epileptic seizure, 1 with cerebellar hemorrhage, and 1 with pneumonia. Observations are continuing on 33 ^{90}Sr-exposed dogs and 22 control dogs at 1800 to 2500 days after being placed on the experiments. The results are related to data from other experiments in which animals have received ^{90}Sr by other routes of administration. (auth)

18558 (CONF-720505-, pp 278-288) OBSERVATIONS SUGGESTING THE VIRAL ETIOLOGY OF RADIATION-INDUCED TUMORS, PARTICULARLY OSTEOGENIC SARCOMAS. Finkel, M. P.; Reilly, C. A. Jr. (Argonne National Lab., IL). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

On the assumption that every cell carries information both for oncogenesis and virogenesis and that radiation causes cancer by inactivating an inhibitor of this information, a search was carried out for viruses in radiation-induced osteogenic sarcomas in CF1 and X/Gf mice. When CF1 mice were treated with both FBJ osteosarcoma virus and ^{90}Sr, both inhibition and enhancement of ^{90}Sr oncogenesis occurred; results varied with different experimental procedures. Antigens identical to or closely related to FBJ antigen were found in 7 or 16 ^{90}Sr-induced bone tumors. Cell-free extracts of five ^{90}Sr-induced osteogenic sarcomas yielded benign bone tumor lines; two other lines were derived from nonradiation-induced bone tumors. These osteoma lines are being maintained by injecting cell-free extracts into newborn CF1 mice. The induced osteomas contain abundant type-C particles. Viruslike particles have been found in every ^{90}Sr-induced osteogenic sarcoma examined in both CF1 and X/Gf mice. With the exception of one tumor, which had only cytoplasmic-A particles, all had type-C particles; one had both C and cytoplasmic-A particles. In X/Gf mice cell-free extracts of ^{90}Sr-induced osteogenic sarcomas have provided three tumor lines that are being maintained by cell-free passage into newborn X/Gf mice. One line produces osteosarcomas, and two lines produce tumors of the reticular tissues. Electron microscopy shows only a few type-C particles in the osteosarcomas but many in the leukemias. (auth)

18559 (CONF-720505-, pp 289-306) TUMOR-SPECIFIC ANTIGENICITY OF OSTEOSARCOMAS INDUCED IN RODENTS BY BONE-SEEKING RADIONUCLIDES. Moore, M.; Williams, D. E. (The Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry, Eng.). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Studies on tumor antigenicity in two models of radionuclide carcinogenesis in rodents were undertaken by attempting induction of tumor-specific immunity with implantation of irradiated (15,000 rads) tumor in syngeneic hosts. Of 16 transplanted osteosarcomas that arose originally in normal or chimeric CBA mice treated with ^{90}Sr (and ^{226}Ra), 6 evoked weak resistance to the transplantation of low tumor-cell inocula (10^3 to 10^4) of the immunizing tumor. In a similar procedure 2 of 7 bone sarcomas induced in normal AS rats by ^{32}P also elicited weak transient resistance to small numbers (10^4 to 10^5) of the immunizing tumor cells. Cross-reactivity tests suggested that such weak antigens as skeletal sarcomas possess may be unique to each tumor. The property of weak antigenicity of radiation-induced osteosarcomas is shared by sarcomas of soft-tissue derivation induced by other physical agents, as well as (spontaneous) mesenchymal sarcomas of unknown aetiology. However, this feature markedly contrasts with sarcomas of bone and soft-tissue origin induced by chemical carcinogens, which, on similar criteria, are highly immunogenic. The possibility that radiation-induced osteosarcomas are deficient in tumor-specific antigens because of immunoselection by the primary host during the long latency period of tumor induction is discussed. (auth)

18560 (CONF-720505-, pp 307-311) DEPENDENCE OF OSTEOSARCOMOGENIC ACTIVITY OF RADIONUCLIDES ON THEIR PHYSICAL PROPERTIES AND PHYSIOLOGICAL STATE OF THE ANIMAL. Moskalev, Yu. I.; Strelt'sova, V. N. (Institute of Biophysics, Moscow). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

The induction of osteosarcomas by bone-seeking radionuclides is dependent on the radiation dose delivered to the skeleton, the energy and effective half-lives of the emitters, and the protraction of administered dose. Optimum osteosarcomogenic doses to rat skeleton were in the range of 15 to 50 krads for beta emitters (^{89}Sr, ^{90}Sr, ^{140}Ba, ^{137}Cs, ^{90}Y, ^{91}Y, ^{144}Ce, ^{147}Pm, ^{140}La, and ^{32}P) and 0.7 to 1.5 krads for the alpha emitter ^{239}Pu. Beta emitters with a short effective half-life (^{90}Y, ^{140}La, and ^{137}Cs) when compared with beta emitters with a long effective half-life (^{91}Y, ^{144}Ce, and ^{90}Sr) have shown relatively low osteosarcomogenic activity. A sharply decreased osteosarcoma incidence was observed after fractional administration of beta emitters as compared to a single injection of the same dose of isotope. Fractionation of ^{239}Pu administration had no significant effect on osteosarcoma incidence. The radionuclide-induced osteosarcoma incidence was identical for both male and female rats but significantly age dependent for each sex. When the sciatic nerve was cut prior to ^{144}Ce admin-

istration, fewer osteosarcomas appeared on the denervated extremities. (auth)

18561 (CONF-720505-, pp 322-346) EFFECT OF LET ON RADIATION CARCINOGENESIS: COMPARISON OF SINGLE AND FRACTIONATED DOSES OF ^{239}Pu, ^{241}Am, ^{32}P, AND X-RAYS ON THE PRODUCTION OF OSTEOSARCOMAS IN RATS. Fabrikant, J. I. (Univ. of Connecticut, Farmington); Hsu, T. H. S.; Knudson, D. H.; Smith, C. L. D. Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Serial radiography, high-resolution autoradiography, histopathology, and the analysis of tumor-cell population kinetics were used to investigate the carcinogenic effects of alpha- and beta-emitting radionuclides and localized x radiation on the induction of bone tumors in male August and hybrid (August × Marshall) rats. Comparisons have been made over a period of 27 months on the effects of single and fractionated doses of high-linear-energy-transfer (LET) and low-LET (x ray) radiations in young rats to assess the characteristic development of radiation-induced changes, neoplastic transformation, and tumor-growth kinetics. Among the lesions observed radiographically following fixation of radionuclides in bone were failure of longitudinal bone growth, abnormal bone molding, pathological fractures, and the production of sclerosing, lytic, and mixed forms of osteosarcoma primarily in the appendicular skeleton but in certain situations in the axial skeleton as well. Fractionation of the administered dose of ^{32}P resulted in an increase in bone-tumor incidence and some indication of earlier development of neoplasia. With high-LET radiation (^{239}Pu and ^{241}Am), fractionation did not affect tumor incidence but did shorten the latent interval. With low-LET radiation, on the other hand, fractionation of dose decreased the tumor incidence, the extent of peritrabecular fibrosis in the metaphyses, and the development of epiphyseal plate abnormalities, but, in general, pathological lesions also include impaired limb growth and reversible and progressive forms of bony architectural damage in the femoral and tibial metaphyses and epiphyses leading to the production of sclerotic and lytic bone tumors. Characteristic early premalignant changes were dependent on the site of irradiation, such as deposition and retention of radionuclide, rather than on LET only. These alterations were frequently metaphyseal sclerosis, followed by growth extension within the bone, secondary cortical destruction, and delayed extension to surrounding soft tissues. The significance of histopathologic changes in relation to autoradiography and radiography for the identification of sites and cellular mechanisms essential to premalignant changes, the induction neoplasia, the accurate determination of latent periods for tumor development, dose–tumor relationships, the dependence of tumorigenesis on LET, and tumor-growth kinetics are discussed. (auth)

18562 (CONF-720505-, pp 358-376) FELINE MALIGNANT BONE TUMORS ASSOCIATED WITH SHORT-TERM EXPOSURE TO ^{89}Sr. Nelson, N. S.; Wright, J. F.; Liddle, C. G. (Environmental Protection Agency, Rockville, MD). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

Two experimental designs have been used in a ^{89}Sr age-sensitivity study in felines. A total of 69 cats, including 6 animals for dosimetry, were divided into groups of 4 adolescent (6 to 10 months of age) and 5 weanling (66 days of age) animals. One group each was given doses of 100, 50, 25, or 0 μCi of ^{89}Sr per day for 30 days in the first design and doses tailored to produce skeletal burdens of 1.95, 0.65, or 0 μCi/g after 65 days of dosing in the second. The primary bioeffects noted involved the hematopoietic system. Usually platelet and white-blood-cell counts were depressed by a factor of 50 to 90%. The severity of depression was correlated with the dose: the higher the dose, the more severe the depression. Radiation-induced hemorrhagic disease sometimes accompanied by myelofibrosis and myeloid metaplasia was the cause of death in 23 of the exposed animals. Three animals surviving 4 months or longer have developed malignant bone tumors so far. One cat developed a giant-cell sarcoma on the left femur, another a fibrosarcoma in the left humerus. The third cat had an osteosarcoma involving the right femur and tibia and a hemangiosarcoma arising from the left femur. At necropsy metastatic lesions were found in lungs (giant-cell-sarcoma and hemangiosarcoma cases), inguinal and abdominal lymph nodes, and kidney (giant-cell-sarcoma case). All tumors suggested a rather high level of malignancy. One of the more important features of these tumors is the fact that they were produced by a pulsed dose of ^{89}Sr. The total rad dose associated with the lesions ranged from about 800 to 2700 rads with essentially all the dose delivered in an 8-month period. The time between the last dose and the appearance of the tumor was from 7 to 19 months. When these observations are compared with those in long-term ^{90}Sr studies where total rad doses are in the range of 8000 to 10,000 rads and latent periods are 18 months to 4 years, there is the suggestion that either the cat is unusually sensitive to radiation insult or the hazard of ^{89}Sr is greater than previously anticipated. (auth)

18563 (CONF-720505-, pp 377-390) IMMUNOLOGICAL AND VIROLOGICAL ASPECTS OF RADIOGENIC LEUKEMIA IN MINIATURE SWINE. Frazier, M. E.; Ushijima, R. N.; Pratt, J. R.; Andrews, T. K.; Rosario, B. (Battelle Pacific Northwest Labs., Richland, WA). Jun 1973.

From 12th Hanford biology symposium on radionuclide carcinogenesis; Richland, Washington, USA (11 May 1972).

In radionuclide carcinogenesis.

A number of diverse factors are known to play a part in the etiology of leukemia in both animals and man. Efforts were directed toward understanding the respective roles of radiation, viruses, and the immune response of the host in the induction of leukemia. Adenovirus and type-C virus were isolated from leukemic swine. The type-C virus has chemical and physical properties consistent with those of known leukemia viruses. The type-C virus was observed only in leukemic swine and cell cultures from leukemic swine. However, long-term cultures from both normal and control animals appear to undergo similar cellular transformation in vitro. Alterations in cellular morphology and growth patterns are readily observable after approximately 20 passages. Chronic exposure to ^{90}Sr inhibited immune responsiveness, as measured by macrophage-migration-inhibition assays. The significance of the impaired immune response and presence of virus in ^{90}Sr swine is discussed. (auth)

18564 (ORO-3728-6) MUTAGENIC EFFECT OF TRANSMUTATION FROM RADIONUCLIDES INCORPORATED INTO DNA OF DROSOPHILA MELANOGASTER. Progress Report, September 1970–May 1973. Lee, W. R. (Louisiana State Univ., Baton Rouge. Dept. of Zoology and Physiology). 1973. Contract AT(40-1)-3728. 8p. Dep. NTIS $3.00.

Phosphorus-33 has a lower mean recoil energy (1.7 eV) than ^{32}P (20 eV); however, all other components of transmutation are the same. The importance of nuclear recoil in producing a mutagenic effect due to transmutation was determined by comparing the genetic effect of transmutation of ^{33}P with ^{32}P. Genetic tests conducted in Drosophila melanogaster to detect losses of the Y- or X-chromosome and to record sex-linked recessive lethals observed in the F_2 and F_3 generation following administration of ^{32}P or ^{33}P are described. (CH)

18565 PATHOLOGIC EFFECTS OF DIFFERENT DOSES OF RADIOSTRONTIUM IN MICE. Nilsson, A. (Foersvarets Forskningsanstalt, Stockholm). Acta Radiol., Ther., Phys., Biol.; 10: No. 1, 115-128(Feb 1971).

Varying doses of ^{90}Sr were administered to 1,430 CBA mice, about 75 days old, to investigate the site of origin, development, and relation between the dose and incidence of leukemia. The significance of the bone marrow, particularly of the thoracic vertebrae, as the site of origin of leukemia, and its relationship to the thymus and spleen in this respect as well as following irradiation, are considered. (auth)

18566 PRIMARY PULMONARY NEOPLASMS IN BEAGLE DOGS EXPOSED TO AEROSOLS OF ^{144}Ce IN FUSED-CLAY PARTICLES. Hahn, F. F.; Benjamin, S. A.; Boecker, B. B.; Chiffelle, T. L.; Hobbs, C. H.; Jones, R. K.; McClellan, R. O.; Pickrell, J. A.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM). J. Nat. Cancer Inst.; 50: No. 3, 675-698(Mar 1973).

To determine the effects of inhaled ^{144}Ce, 126 Beagle dogs (including 15 controls) were exposed to aerosols of either ^{144}Ce in fused clay or stable cerium in fused clay. To date, 15 dogs have died 143 to 410 days after inhalation exposure from radiation pneumonitis and pulmonary fibrosis. Primary pulmonary neoplasms caused the deaths of five dogs 750 to 1318 days after inhalation exposure. Calculated pulmonary radiation doses until death ranged from 23,000 to 48,000 rads. Pulmonary hemangiosarcomas were found in all five dogs and metastasis in four. In addition, one dog had a pulmonary fibrosarcoma and another had a bronchiolo-alveolar carcinoma, both of which metastasized to the tracheobronchial lymph nodes. Only three dogs with similar initial lung burdens of ^{144}Ce died without pulmonary neoplasms, at 186, 193, and 410 days after inhalation exposure. The 91 dogs exposed to ^{144}Ce-fused clay and all controls have survived 239 to 1565 days after inhalation exposure including 44 surviving >750 days, with pulmonary radiation doses from 2 to 36,000 rads. (auth)

Nuclide Kinetics and Toxicology

Refer also to abstracts 17981 and 20546.

Man

Refer also to abstract 18582.

18567 (BNL-17917) RADIOISOTOPES IN MEDICINE. Atkins, H. L. (Brookhaven National Lab., Upton, N. Y.). 1973. 27p. (CONF-730119-3). Dep. NTIS $3.50.

From American Physical Society Meeting; New York, New York, USA (29 Jan 1973).

A review is presented on the use of radioisotopes in nuclear medicine with emphasis on diagnostic techniques. The use of ^{99m}Tc and other isotopes in radiopharmaceuticals is discussed and the following characteristics of an ideal radiopharmaceutical are discussed; half-life; energy range of gamma rays; availability; purity; biochemical behavior; specific activity; sterility; and pyrogenicity. Other topics discussed are: use of colloidal radiopharmaceuticals for studies on the liver, spleen, bone marrow, and lymph nodes; use of chelates combined with radionuclides for brain scanning and studies on renal anatomy and physiology; use of labeled red blood cells for determination of red cell mass; semiconductor detectors; isotope cameras; use of short-lived radionuclides produced by cyclotrons; and Fresnel zone plate imaging. (HLW)

18568 PRODUCTION AND HUMAN INHALATION OF PLUTONIUM LABELLED PARTICLES IN THE SUB-MICRON RANGE. Waite, D. A. Stillwater, OK; Oklahoma State Univ. (1972). 104p. University Microfilms Order No. 73-15,271.

Thesis (Ph. D.).

Since all radiological limits are based on the dose-effect relationship for the irradiation of biological systems, one of the prime considerations in evaluating the potential hazards from internally deposited radioisotopes is the biological dose received by various organs. In such a determination the accurate estimation of the activity intake, A_0, is of paramount importance. Since construction of acute intake is not often possible, the only alternative solution to the problem is the estimation of A_0 after the fact by any measure available. Following an analysis of calibration errors that exist when the estimation of A_0 is computed using human phantoms, an experiment was proposed to minimize these errors. A limited number of experiments were carried out using human volunteers inhaling an aerosol of known activity, solubility, and particle size. Data from the volunteers was collected over a definite period of time by enough independent means to indicate both levels and trends concerning aerosol retention, excretion, translocation, and distribution. An aerosol production apparatus built around an ultrasonic nebulizer was constructed and tested. Specifically designed to operate at high efficiency and low air volume, the apparatus is ideally suited for work with aerosol particles tagged with less readily available isotopes. Sub-micron particles generated by this method are hollow and have widely varying densities depending upon their size. Excretion, retention, and distribution results following the human inhalation of these particles are consistent with I.C.R.P. Lung Dynamics Task Group models. The results of such inhalations give a consistent pattern of lung deposition showing a high lung retention with a long, retained half period for atypical breathing patterns aimed at maximizing pulmonary deposition. The human to human-phantom cross calibrations which were provided by these human inhalation experiments showed that using realistic chest phantoms to supply basic calibration data and body-build parameters to modify such data is a valid method but one of first-order correction only. Without any phantom calibration correction, errors up to a factor of 10 may occur. (Diss. Abstr. Int., B)

18569 MEASUREMENTS ON THE UPTAKE OF RADIONUCLIDES BY THE THYROID. Report of AIEA Research Group. (IAEA, Vienna). J. Biol. Med. Nucl.; 7: No. 30, 25-32(1972). (In French).

A study group of the I.A.E.A. held a meeting in 1971 at Vienna. A report was subsequently published in which the recommendations following the 1960 meeting on the uptake of radionuclides by the thyroid were modified. The clinical conditions are defined for the different uptake tests: early, delayed, stimulation, suppression, and discharge. The techniques utilized for the early measurement of uptake are described together with delayed measurement techniques. Other measurement methods are also described e.g., high sensitivity methods, scintigraphic methods, profile scintigraphy, and whole-body counting. (FR)

Animals

Refer also to abstract 18239.

18570 (COO-1787-17) LYMPH TRANSPORT OF $^{239}PuO_2$ IN DOGS. Gomez, L. S. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). May 1973. Contract AT(11-1)-1787. 84p. Dep. NTIS $6.25.

Thesis.

The translocation of high-fired $^{239}PuO_2$ particles via the lymphatic system from a simulated puncture wound in a dog's paw was studied with two major objectives in mind. The first was to study the effect of lymphadenectomy on PuO_2 translocation, and the second was to determine the mode by which PuO_2 is rapidly translocated from wound site to lymph node. Minor experiments were performed to clarify anatomical questions which arose during this study. The lymphadenectomy experiments included lymph node excisions on the day of Pu implant, as well as excisions 14 days after implant. Comparisons were made between dogs with and without excision of the left superficial cervical lymph node (LSCLN). Build-up of Pu in the LSCLN was determined by in vivo counting of the low-energy x-ray complex with a thin NaI(Tl) detector. The dogs were killed at selected times after implant and the α-activity was determined in selected tissues. The data suggest that PuO_2 was transported via the lymph system. Higher levels of Pu were found in the liver, spleen, and hepatic lymph nodes of lymphadenectomized dogs than in the intact dogs. Implications of the data to therapeutic lymph node removal from workers contaminated with Pu are discussed. (CH)

18571 EXPERIMENTAL DATA ON THE CONTAMINATION OF ANGUILLA ANGUILLA (L.) BY CHROMIUM 51 AND ITS EXCRETION. Descamps, B.; Foulquier, L.; Aguesse, P.; Grauby, A. (CEN de Cadarache, Saint-Paul-les-Durance, France). Compt. Rend., Ser. D; 276: No. 7, 1193-1196(12 Feb 1973). (In French).

Eels were kept in freshwater contaminated with ^{51}Cr. The fixing of this isotope in the eel rapidly increased until the 20th day. The specific activity observed in the digestive tract was particularly high, the activity of this tract representing 70% of the total activity absorbed by the eel. The liver appears to play a storage role. The excretion of ^{51}Cr was rapid during the first few days and then much less rapid. Two effective half-lives were determined: 4 and 19 days for the whole fish; 3 and 17 days for the intestine. (FR)

18572 POLONIUM-210 METABOLISM IN RABBITS AFTER A SINGLE INTRAVENOUS AND INTRATRACHEAL INJECTION. Parfenov, Yu. D.; Poluboyarinova, Z. I. (Inst. of Biophysics, Moscow). Int. J. Radiat. Biol.; 23: No. 5, 487-493(May 1973).

The metabolism of ^{210}Po was studied in the body of rabbits after a single intravenous and intratracheal injection of 25 μCi of polonium nitrate (0.008 μCi/g). The general distribution pattern of ^{210}Po was identical for both routes of injection. The highest concentration was observed in kidneys, irrespective of the injection route. Judged by the accumulated amounts of the radionuclide, the kidneys are followed by spleen, liver, blood, and lungs. After an intravenous injection, ^{210}Po tended to accumulate in spleen and liver to a greater extent than after an intratracheal injection; in kidneys the reverse was the case. Elimination rates of ^{210}Po in various organs and tissues of rabbits did not differ essentially and were not dependent on the administration route. The elimination rates of ^{210}Po from rabbit organs was 3 to 4 times greater than from the organs of other animals. (auth)

18573 RADIOISOTOPE RESIDUES AND RESIDUES OF DICHLORVOS AND ITS METABOLITES IN PREGNANT SOWS AND THEIR PROGENY DOSED WITH DICHLORVOS-^{14}C OR DICHLORVOS-^{36}Cl FORMULATED AS PVC PELLETS. Potter, J. C.; Boyer, A. C.; Marxmiller, R. L.; Young, R.; Loeffler, J. E. (Shell Development Co., Modesto, CA). J. Agr. Food Chem.; 21: No. 4, 734-738(1973).

In three separate trials pregnant sows were fed dichlorvos and dichlorvos-^{14}C, dichlorvos-^{14}C, and dichlorvos and dichlorvos-^{36}Cl, respectively, during the last third of the sows' gestation period at a rate of 4 mg of dichlorvos per kg of body weight per day. In all the trials the dichlorvos was formulated in polyvinyl chloride pellets containing 20 to 21% dichlorvos. After farrowing, the sows and piglets were held for periods as long as 21 days before being sacrificed. During this period the piglets nursed from their own mothers. The daily rates of excretion of ^{14}C from the sows which had been dosed with dichlorvos-^{14}C only were as follows: feces, 5.4%; the pellets recovered from the feces, 53.6%; urine, 4.3%; and expired air, 6.7%. The recovery of ^{36}Cl from the sows dosed with dichlorvos and dichlorvos-^{36}Cl was as follows: feces, 5.5%; the pellets recovered from the feces, 56.5%; urine, 26.1%; and sow carcass, 8.1%. No residues of dichlorvos, dichloroacetaldehyde, demethyl dichlorvos, dichloroacetic acid, or

dichloroethanol were found in the tissues of the sows and piglets, although the tissues contained ^{14}C and ^{36}Cl residues ranging from 0.3 to 18.0 ppM equivalents. The ^{14}C and ^{36}Cl residues in the tissues are believed to be due to degradation of the vinyl group in dichlorvos into ^{36}Cl ions and the incorporation of the ^{14}C into normal tissue constituents such as glycine, serine, creatine, glucose, glycogen, fatty acids, cholesterol, choline, lecithin, and ribonucleic acid. (auth)

18574 IMPORTANCE OF DIFFERENT LEVELS OF POTASSIUM IN THE DIET OF WHOLE-BODY ^{40}K COUNT AND MUSCLE AND BLOOD POTASSIUM. Johnson, R. K.; Walters, L. E.; Whiteman, J. V. (Oklahoma Agricultural Experimental Station, Stillwater). J. Anim. Sci.; 35: No. 5, 931-936(Nov 1972).

The influence of three levels (1.31, 1.03 and 0.29% K) of dietary potassium on ^{40}K count, blood serum and muscle tissue potassium was determined using 36 crossbred Angus-Hereford steers. Diets were fed for 2-week periods and appropriate samples and measurements were collected at 14-day intervals over a 60-day period. Measurements were made on steers unshrunk and after 24 hr off feed and water. Carry-over effect means were nonsignificant for each trait. The steers on the high potassium diet had 447.5 higher unshrunk ^{40}K counts per minute and 218 higher shrunk counts per minute than steers on the low potassium diet ($P < 0.01$). The steers on the high potassium diets had higher blood serum and muscle potassium concentrations than those on low potassium diets although these differences were not significant. Animal to animal variation in potassium concentration was an important source of variation in this study. It appears tissue potassium concentrations are not constant between animals and that this variation could be a limiting factor to the precision of estimating lean in live animals by ^{40}K counting. These data indicate that the primary influence of dietary potassium to ^{40}K counting is the effect on potassium content of the gastrointestinal tract contents. (auth)

18575 RADIOPHOSPHORUS PERMEABILITY THROUGH THE SYNOVIAL MEMBRANE OF KNEE JOINT UNDER EFFECT OF IMPULSE SINUSOIDAL MODULATED CURRENTS. Faitel'berg-Blank, V. R.; Perevoshchikov, Yu. O. (Inst. of Agriculture, Odessa). Fiziol. Zh., Akad. Nauk Ukr. RSR; 19: No. 3, 388-395 (1973). (In Russian).

The effect of impulse sinusoidal modulated currents on the diffusion of ^{32}P through the knee joint synovial membrane was studied in experiments on 206 cats. Together with the studies on the permeability of the knee joint synovial membrane for ^{32}P the content of ^{32}P was investigated in the liver, lungs, spleen, and kidneys under the effect of the agent under investigation. The greatest change in the knee joint absorption function was observed when influenced with the I type of sinusoidal-modulated currents work (regime N 1), with an impulse duration of 2 sec, current density of 0.1 mA/cm^2 with 20 minute exposition at 50% depth of modulation at frequency of 40 Hz. Phosphorus-32 resorption in the knee joint cavity is considerably changed under the influence of the IV type of the work (regime N 1) with an impulse duration 2 sec, at a frequency of 40 Hz, current density of 0.5 mA/cm^2 with 50% deep modulation, and 10-minute exposure. (auth)

Plants

Refer also to abstract 20615.

18576 (UCR-34-P-51-36) BEHAVIOR OF CERTAIN SYNTHETIC CHELATING AGENTS IN BIOLOGICAL SOIL SYSTEMS. Annual Progress Report. Wallace, A. (California Univ., Riverside (USA). Dept. of Soil Science and Agricultural Engineering). 15 May 1973. Contract AT(04-3)-34. 74p. Dep. NTIS $5.75.

The relationship of chelating agents, both synthetic and natural, to the bioaccumulation of heavy metal radionuclides and potentially toxic heavy metals is reviewed. Evidence shows that the chelating agent, diethylenetriaminepentaacetate (DTPA), does facilitate the transport through bush bean and soybean plants of many different heavy metals and their radionuclides. This same characteristic of DTPA also makes it useful in decontamination both in bodies and in the environment. The pH of the soil is of great consequence in the amount of the nuclide absorbed by the plants. This is largely because of the stability constant of the metal chelate which is pH dependent. At the pH where metal chelate is most stable, most metal is accumulated by the plant. This situation obtains unless there is a relatively large excess of the chelating agent where, at least for some elements and some plants, competition reactions occur. Chelating agents, natural or synthetic, magnify many fold the rate at which many nuclides move through soil. The effect of chelating agents in soil-plant systems then is multiple. Data on the rate of transport of Fe, Mn, Zn, Cu, Al, Tl, Co, Ni, Sn, Pb, and Mo through soil and content in the leaves and stems of the plants are summarized. (CH)

New Tracer Techniques

Refer also to abstracts 17911 and 20357.

18577 (BNL-17991) SMALL COMPUTER ASSISTED ANALYSIS OF CAMERA RENOGRAMS. Esser, P. D.; Bradley-Moore, P. R.; Atkins, H. L.; Robertson, J. S.; Ansari, A. N. (Brookhaven National Lab., Upton, N. Y.). 1972. 13p. (CONF-730627-2). Dep. NTIS $3.00.

From 3rd symposium on the sharing of computer programs and technology in nuclear medicine; Miami, Florida, USA (16 Jun 1973).

A program was adapted for use with a camera device interfaced to a small dedicated computer. The system combines the advantage of sequential imaging with the convenience of ready access to the computer by the physician. Following the administration of ^{99m}Tc-human serum albumin, the patient can be accurately positioned with respect to the field of view of the camera. A static image allows calculation of relative blood background contribution to each kidney. Subsequently, serial imaging is performed, first with ^{131}I-Hippuran and then ^{99m}Tc-DTPA. The resultant time-activity curves derived from such studies are analyzed with the aid of the computer program. Information derived from such analysis includes time of maximum for each curve, the relative accumulation rate of radioactivity by each kidney, and efficiency of isotope removal from each kidney. The program offers the possibility of deriving quantitative information for comparative renal function. (auth)

18578 BACTERIAL CONTAMINATION OF RADIONUCLIDE GENERATORS: FACT OR FICTION. Hamilton, J. W. (Veterans Administration Center, Bay Pines, FL). Amer. J. Med. Technol.; 38: No. 4, 105-108(Apr 1972).

The use of ^{99m}Tc radionuclide generators is described. The likelihood of contamination of the eluant was determined by collecting bacterial cultures at the generator during the elution process. Various methods are described for reducing the bacterial population in the vicinity of the generator. The study showed that some hospitals use poor judgment in the location of their nuclide generator, but in spite of this, the danger of contamination of the eluted product is practically non-existent. Proper location of the generator, along with appropriate precautionary measures such as ultraviolet light, plastic cover hoods, and area germicides will lower the bacterial population and reduce the chance of contamination. (auth)

18579 MICROASSAY FOR THE QUANTITATION OF CYTOTOXIC ANTITUMOR ANTIBODY: USE OF ^{125}I-IODODEOXYURIDINE AS A TUMOR CELL LABEL. LeMevel, B. P.; Wells, S. A. Jr. (National Cancer Inst., Bethesda, MD). J. Nat. Cancer Inst.; 50: No. 3, 803-806(Mar 1973).

A microassay was developed for the detection of cytotoxic tumor-specific antibody against ^{125}I-iododeoxyuridine-labeled sarcoma cells induced by 3-methylcholanthrene in C57BL/6N mice. The technique used small amounts of serum and cells and was simple, sensitive, and objective. (auth)

18580 NEW T_3 AND T_4 TESTS FOR THE EVALUATION OF THE INDEX OF FREE THYROXINE. Gratot, I. (CEN de Saclay, Gif-sur-Yvette, France); Hegesippe, M.; Rolleri, E. J. Biol. Med. Nucl.; 7: No. 30, 14-20(1972). (In French).

A new T_3 test based on the use of a reversible adsorbent (MSA microspheres of albumin serum) and a new T_4 test are described together with their simultaneous utilization in thyroidian pathology for the evaluation of the free thyroxine index. This index enables alterations in the concentration of free TBG sites to be taken into account. The euthyroid range obtained with the T_4 test is 3.5 to 11 μg T_4%. (FR)

18581 PRELIMINARY STUDY OF THE FIXING OF TECHNETIUM POLYPHOSPHATES ON BONES IN VIEW OF SCINTIGRAPHY OF THE SKELETON. Gelis, G.; Vie, M. T.; Marignan, R. (Univ., Montpellier, France). J. Biol. Med. Nucl.; 7: No. 30, 21-24(1972). (In French).

The fixing of various technetium polyphosphates in the bones of rabbits was studied. The complexes whose degree of polymerization is equal to or less than 3, present bone seeking properties that render them useful for the exploration of the skeleton. These products that do not seem useful for kinetic studies enable scintigraphic images of satisfactory quality to be produced. (FR)

18582 POSSIBILITIES OF TUMOR LOCALIZATION IN THE UTERUS BY MEANS OF CONTACT RADIOMETRY ^{32}P. Kolcina, T. P. (Wissenschaftlichen Forschungsinstituts fuer Onkologie, Moskow). Radiobiol.-Radiother.; 14: No. 3, 281-286(1973). (In German).

Isotope examination with ^{32}P was used for determination of tumor localization and demarcation to the healthy endometrial tissue being decisive of the kind of therapy to be adopted. Ac-

cording to the extent of radioactive phosphorus accumulation in the course of examination lasting 3 days, four groups of patients were classified. Reliable data on a tumor demonstration in the endometrium (69.2 ± 5.6%) belong to group 1, suspect data of an endometrial carcinoma (21.5 ± 5.9%) to group 2, doubtful hints (6.2 ± 2.0%) to group 3, and negative parameters (3.1 ± 2.15%) to group 4. The reliability of the obtained information on location and spread of a tumor was checked by extirpated organs and by means of hysterography. True results were found to be obtained by isotope examination in 81.1% of the cases. The given method of examination may have a considerable value for the determination of tumor localization if other methods of examination do not seem to be indicated. (auth)

18583 PROCEEDINGS OF THE FIRST NATIONAL MEETING ON BIOPHYSICS AND BIOTECHNOLOGY IN FINLAND. Conference Held in Helsinki, Finland, January 4-5, 1973. Patomaki, L.; Kiuru, A. (eds.). Helsinki; Technical Research Centre of Finland (1973). 241p. (CONF-730121-).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973).

Separate abstracts were prepared for 21 of the 59 papers presented. The remaining 38 papers were not within the scope of NSA. (WHK)

For abstracts of individual papers see: 17862, 17863, 17919, 18321, 18322, 18344–18346, 18416, 18422, 18451, 18474, 18475, 18584, 18585, 18935, 19156, 19157, and 20146–20148.

18584 PHYSICAL ASPECTS IN THE CLINICAL USE OF RADIONUCLIDES. Rekonen, A. (Central Hospital, Jyvaskyla, Finland). pp 13-20 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The physical aspects in the area of nuclear medicine are considered. It is concentrated into some new possibilities in scintigraphy and in function measurements. (FI)

18585 RETENTION STUDY OF CADMIUM-115m BY WHOLE-BODY COUNTING. Rahola, T.; Aaran, R. K.; Miettinen, J. K. (Univ. of Helsinki). pp 59-64 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The retention of cadmium in man was studied using ^{115m}Cd and whole-body counting techniques. About 75% of the cadmium was eliminated, primarily in the feces, within the first 3 to 5 days. After 20 days, fecal and urinary excretion of cadmium appear to be equal, both at a very low level. (ERB)

18586 TOTAL AND UNBOUND TESTOSTERONE LEVELS IN THE NEWBORN AND IN NORMAL AND HYPOGONADAL CHILDREN: USE OF A SENSITIVE RADIOIMMUNOASSAY FOR TESTOSTERONE. Forest, M. G.; Cathiard, A. M.; Bertrand, J. A. (Hospital Debrousse, Lyon, France). J. Clin. Endocrinol. Metab.; 36: No. 6, 1132-1142(Jun 1973).

A sensitive and reliable radioimmunoassay combined with celite column chromatography for specific determination of plasma testosterone (T) is described. The percentage binding was measured by equilibrium dialysis. In 28 normal newborns, total T concentration is significantly higher in male (68.1 ± 59.5) than in female newborn infants (12.0 ± 6.2) while binding of T increases rapidly after birth. Although there is no sex difference in TeBg capacity, levels of unbound T in the first two weeks of life are still significantly higher in male than in female infants. There was no sex difference in 62 normal prepubertal children studied, the total concentration being 6.62 ± 2.46 and 6.58 ± 2.48 ng/100 ml in boys and girls, respectively; the binding of T and unbound T levels were identical in both. In 17 patients with Turner syndrome, total T concentration (13.6 ± 3.1 ng/100 ml) was significantly higher than in prepubertal children and increased (21.5 ± 2 ng/100 ml) under moderate estrogen therapy while the percentage of T bound to protein did not change (96.65% ± 0.29 and 96.81% ± 1.4 respectively). However unbound T levels remained ¼ to ½ that of normal adult females. In 13 patients with primary hypogonadism, total T concentration was similar to that of Turner patients (13.12 ± 5.4 ng/100 ml) so as were the percentage of T bound to proteins and unbound T levels. The physiological implications of free and bound testosterone concentrations in newborns, prepuberal and hypogonadal children are discussed. (auth)

18587 SIMULTANEOUS MEASUREMENT OF MULTIPLE PLASMA STEROIDS BY RADIOIMMUNOASSAY DEMONSTRATING EPISODIC SECRETION. West, C. D.; Mahajan, D. K.; Chavre, V. J.; Nabors, C. J.; Tyler, F. H. (Univ. of Utah, Salt Lake City). J. Clin. Endocrinol. Metab.; 36: No. 6, 1230-1236 (Jun 1973).

A method for measuring cortisol, corticosterone, testosterone, progesterone, and 17-OH progesterone simultaneously in 2 ml of plasma has been developed especially for episodic secretion studies in which many frequent assays are required. Steroids were extracted from plasma, separated into 4 fractions by paper chromatography, and individual steroids in each fraction were measured by radioimmunoassay. The individual steroid radioimmunoassays were demonstrated to be sensitive, specific, accurate, and precise. Base line 8 AM plasma steroid levels were measured in normal males and menstruating females both before and after ovulation. The values obtained were in good agreement with those previously reported by other investigators using different methods. In order to establish the normal diurnal variation in both sexes, plasma steroid levels were measured at 20-min intervals throughout the day in a normal man and a preovulatory woman. When plasma steroid levels were plotted against time frequent intermittent peaks that were consistent with episodic secretion were observed. As a result of this study progesterone, corticosterone, testosterone, and 17-OH progesterone have been added to the list of hormones that are secreted episodically. Corticosterone peaks were well synchronized with cortisol peaks, but those for progesterone, testosterone, and 17-OH progesterone were not. In the male 17-OH progesterone and testosterone peaks correlated well. It was concluded from these observations that corticosterone is secreted directly into the bloodstream by the adrenal under ACTH control, and that the other steroids are secreted from non-adrenal sources under other controls. The synchrony between plasma testosterone and 17-OH progesterone levels in the male suggests a common origin, presumably the testes. (auth)

18588 RADIOIMMUNOASSAY OF α-FETOPROTEIN, WITH SPECIAL REFERENCE TO THE COMPARATIVE STUDY WITH LIVER SCINTIGRAPHY. Hisada, K.; Tonami, N.; Aburano, T.; Kawamura, Y. (Kanazawa Univ., Japan). Nippon Iji Shimpo; No. 2527, 27-31(Sep 1972). (In Japanese).

A brief description of α-fetoprotein radioimmunoassay using ^{125}I, the result of its clinical application to various liver diseases, and a discussion of its significance in diagnosis of primary liver neoplasms compared with liver scintigraphy are presented. A total of 188 cases including 12 cases of primary liver neoplasms, 20 normal cases, 37 cases of various hepatitis, 22 cases of liver cirrhosis, and 37 cases of stomach neoplasms were subjects of the clinical study. Liver scintigraphy using ^{198}Au colloid was simultaneously given to all subjects, and micro Ouchterlony and electrosyneresis were also applied to some subjects for a comparative study. Analysis of the result of fetoprotein radioimmunoassay using 200 mμg/ml as positive standard indicated that 10 out of 12 cases (83%) of primary liver neoplasms, 2 out of 59 cases (3.4%) of various hepatitis and cirrhosis, and 4 out of 37 cases (10.8%) of stomach cancer were found positive. A comparative study was conducted of fetoprotein radioimmunoassay, liver scintigram, and postmortem histological findings in seven cases. Liver scintigraphy failed to detect liver neoplasms in two out of seven cases (71% success). In one of these two cases, fetoprotein was negative with the value under 30 mμg/ml. However, in another case fetoprotein was found positive, thus leading to establish diagnosis of liver neoplasm. (JA)

MATERIALS

18589 (CONF-710358-(Absts.)) 31ST PHYSICAL ELECTRONICS CONFERENCE, GAITHERSBURG, MARYLAND, MARCH 15–17, 1971. (National Bureau of Standards, Washington, D. C.). 1971. 55p.

Abstracts are given of 46 papers that were presented in six sessions. Some of the topics dealt with include: surfaces, adsorption of gases and alkali metals on metals such as W and Mo, spectra, photoemission, surface electron states, sputtering, electron reactions, desorption, semiconductor materials and devices, electron emission, etc. (DLC)

18590 (CONF-710566-(Absts.)) SYMPOSIUM ON THERMAL ANALYSIS, BOMBAY, MAY 11–12, 1971. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 45p.

Abstracts are given of ~40 papers that were presented in four sessions dealing with calorimetry, phase transitions, instrumentation, and thermal analysis in general. (DLC)

18591 (CONF-711226-(Absts.)) SYMPOSIUM ON HIGH TEMPERATURE MATERIALS, HYDERABAD, INDIA, DECEMBER 13–15, 1971. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 1971. 23p.

Abstracts are given of 35 papers which were presented at six sessions dealing with deformation mechanisms, heat-resistant materials and corrosion behavior, sintering and related phenomena, physical studies, structural studies, and applications. (DLC)

18592 (CONF-720349-(Absts.)) THIRTY-SECOND ANNUAL CONFERENCE ON PHYSICAL ELECTRONICS, ALBUQUERQUE, NEW MEXICO, MARCH 20–22, 1972. (Sandia Labs., Albuquerque, N. Mex.). 1972. 62p. Dep. NTIS $5.25.

Abstracts are given of 53 papers that were presented in six sessions, dealing with: electron field emission, adsorption and chemisorption of gases on metals and alloys, desorption, appearance potential spectroscopy, electron emission, surface electronic states, ionization, photoemission, Auger electrons, and semiconductor surfaces and devices. (DLC)

18593 (CONF-721228-(Absts.)) SYMPOSIUM ON ELECTRICAL, ELECTRONIC, AND MAGNETIC MATERIALS, MADRAS, DECEMBER 7–9, 1972. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 1972. 28p.

Abstracts are given of 41 papers which were presented in seven sessions. Some of the materials covered include metals and alloys, ceramics, Ge, Ta capacitors, Al conductors, Ni alloys, permanent magnet alloys, soft magnets, Alnico, magnetic properties of various materials (Co–Al, Mn–Al, Fe–Ge, Fe–Al), liquid insulants, transition metal dichalcogenides, $BaTiO_3$, Al_2O_3, Schottky barrier devices, Si materials, PbTe, As–Se–Te, and recording media. (DLC)

18594 (LBL-1400) INORGANIC MATERIALS RESEARCH DIVISION ANNUAL REPORT, 1972. (California Univ., Berkeley. Lawrence Berkeley Lab.). Apr 1973. Contract W-7405-eng-48. 231p. Dep. NTIS $7.60.

Very brief summaries of individual studies are reported under the sections of four major areas as follows: (I) Chemistry—Inorganic Chemistry, Electrochemistry, Solid-State Chemistry and Physics, Physical Chemistry, and Nuclear Science; (II) Metallurgy—Crystal Imperfections, Relationship of Microstructure and Properties, High-Voltage Electron Microscopy, Alloy Design, High-Field Superconductivity, Powder Metallurgy, Thermodynamics of Metal Systems, and Advanced Materials; (III) Ceramic Science—High-Temperature Reactions, Microstructure and Behavior of Ceramic Materials, and Relationship of Microstructure to Properties; and (IV) Solid-State Physics—Theoretical Solid-State Physics, Far-Infrared Properties of Solids, Superconductivity, and Experimental Solid-State Physics and Quantum Electronics. Practically all of the information had been published in detail, and a list of 1972 publications and reports follows each section. Administrative information is given in the Appendices. (LMT)

18595 POTENTIAL APPLICATION OF THE CHEMICAL VAPOUR DEPOSITION PROCESS TO THE DEVELOPMENT OF COMPOSITES. Poeschel, E. (Battelle Institut eV, Frankfurt am Main). Z. Werkstofftech.; 4: No. 4, 215-221(1973). (In German).

A description of the chemical vapor deposition (CVD) process and its potential applications to the development of new materials, specifically composites, is presented. Particular importance is attached to the coating of powders (particle composites); the production of fibers and their coating with adhesive and wetting agents and with diffusion and reaction barriers (fiber composites), and the deposition of corrosion-inhibiting, heat-insulating, and wear-resistant surface layers (laminated composites). 9 figures, 15 references. (GE)

18596 METALLURGICAL APPLICATIONS OF ION IMPLANTATION AND ION BOMBARDMENT. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Vacuum; 23: No. 3, 79-84(Mar 1973).

From international conference on ion-surface interaction: sputtering and related phenomena; Aldermaston, Eng. (25 Sep 1972).

The physical background to the metallurgy of ion implantation is discussed. The fate of implanted atoms is considered in the content of the precipitation process which occur as a consequence of exceeding the solubility limit during implantation. The metallurgical applications of ion implantation and ion bombardment are discussed under the following headings: surface and interfacial energies, surface applications, superconductivity, and void formation. (auth)

18597 STUDY OF CRYSTALLINE TRANSFORMATIONS AT HIGH TEMPERATURES: ABOVE 2000K. International Colloquium, Odeillo, France, September 27, 1971. Paris; Centre National de la Recherche Scientifique (1972). 486p. (In Several Languages).

Fifty-five papers were presented at this conference, 38 of which were abstracted separately. (FR)

For abstracts of individual papers see: 18628, 18629, 18654–18683, and 18832–18837.

Ceramics and Cermets

Refer also to abstracts 17902, 18037, 18698, 18700, 18701, 18751, 18858, 18915, 20235, 20270, 20285, 20286, 20298, 20400, 20403, 20411, and 20609.

18598 (CEA-CONF-2320) MACHINING OF MULTIHOLE GRAPHITE BLOCKS. Bujas, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 18 Apr 1973. 6p. (CONF-730544-1). Dep. NTIS (U. S. Sales Only) $3.00.

From 7th Dragon project quality control working party meeting; Julich, F.R. Germany (8 May 1973).

Multihole graphite blocks for reactor fuel applications require fine tolerances. Experiments were performed using helicoidal drills, but required specifications could not be met. Testing with gun drills was performed and results showed that this method was acceptable and could be performed for industrial production. Control methods are described. (MCW)

18599 (DP-MS-72-31) OXIDATION OF SINTERED COBALT OXIDE. Ott, W. R.; Rankin, D. T. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 18 Aug 1972. Contract AT(07-2)-1. 15p. (CONF-720980-2). Dep. NTIS $3.00.

From American ceramic society fall meeting; Philadelphia, Pennsylvania, USA (24 Sep 1972).

The kinetics and mechanism of the air oxidation of cobaltous oxide to spinel ($6\ CoO + O_2 \rightarrow Co_3O_4$) were studied in sintered pellets of CoO and $Co_{0.5}Mg_{0.5}O$ using isothermal weight change determinations and thermogravimetric analyses. Corrosion of the two oxides and $CoAl_2O_4$ in flowing water at 125°C was also studied. 8 figures. (DLC)

18600 (FRNC-TH-326) MEASUREMENT OF THE THERMAL DIFFUSIVITY OF $(U,Pu)O_2$ OXIDES. Studies as a Function of Stoichiometry and Pu Contents. Weilbacher, J. C. (Paris Univ. (France)). 1972. 111p. (In French). NTIS (U. S. Sales Only).

Thesis.

The principles of the flash method are reviewed. The device developed to measure the thermal diffusivity is described. This device enables thermal diffusivity measurements to be made in a controlled atmosphere over a wide temperature range (700 to 2750°C). It consists of a heated enclosure (induction oven) provided with a sample holder, an instantaneous energy source (Nd doped glass laser), and a device permitting accurate measurements to be made of the temperature increase of the back face of the sample. Studies of the effect of temperature on the thermal diffusivity of mixed oxides $U_YPu_{1-Y}O_{2-X}$ enabled the lattice and electronic contributions of the thermal conductivity to be established. The effects of deviations from stoichiometry were estab-

lished. Studies of the effect of the paramagnetic ions in solution on the thermal diffusivity were made for different Pu concentrations. The limiting effect of vacancies on the high-temperature conductivity was established. (FR)

18601 (HEDL-TME-73-44) ROOM-TEMPERATURE OXIDATION OF HYPOSTOICHIOMETRIC MIXED-OXIDE FUELS. Woodley, R. E.; Gibby, R. L. (Hanford Engineering Development Lab., Richland, Wash.). May 1973. Contract AT(45-1)-2170. 47p. AT.

Hypostoichiometric $U_{0.75}Pu_{0.25}O_{2-x}$ is oxidized at room temperature by water vapor but not by oxygen. The extent of oxidation depends upon the magnitude of the surface area accessible to the fuel pellet exterior through surface-connected porosity. The rate of oxidation depends upon the water vapor concentration, the accessible surface area, and the degree of substoichiometry. At very low moisture levels, the rate is first order with respect to the $H_2O(g)$ concentration, while at higher levels the rate becomes independent of the concentration of $H_2O(g)$. (5 tables, 7 figures) (auth)

18602 (N-73-17718) FISSION-GAS RELEASE FROM URANIUM NITRIDE AT HIGH-FISSION-RATE DENSITY. Weinstein, M. B.; Kirchgessner, T. A.; Tambling, T. N. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1973. 57p. (NASA-TN-D-7171). NTIS.

A sweep gas facility was used to measure the release rates of radioactive fission gases from small UN specimens irradiated to 8% burnup at high fission-rate densities. The measured release rates were correlated with an equation whose terms correspond to direct recoil release, fission-enhanced diffusion, and atomic diffusion (a function of temperature). Release rates were found to increase linearly with burnups between 1.5 and 8%. Pore migration was observed after operation at 1550°K to over 6% burnup. (auth)

18603 (N-73-18571) ULTRAVIOLET AND CHARGED-PARTICLE IRRADIATION OF PROPOSED SOLAR CELL COVERSLIDE MATERIALS AND CONDUCTIVE COATINGS FOR THE HELIOS SPACECRAFT. Fry, J.; Nicoletta, C. A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jun 1972. 112p. (NASA-TM-X-65945). NTIS.

Coverslide materials consisting of Corning 7940 fused silica, multilayers of titanium and manganese oxides (blue reflector), and indium oxide (conductive coating) were exposed to 16 UVSC up to 800 EUVSH in vacuum. Slight changes in optical transmittance and optical absorptance were found in the 200- to 360-mμ regions of the fused silica and conductive coating respectively. Exposure to 4-keV protons and 4.5-keV electrons in vacuum, produced decreases of several percent in transmittance, 200- to 360-mμ region in the fused silicas after total fluxes $\leq 10^{14}$ particles/sq cm. Sheet resistance of the conductive coating increased above 1.0 kilo-ohm/square after a total flux $\leq 10^{14}$ particles/sq cm. Solar cells with coverglasses utilizing the indium oxide conductive coating were exposed to 1-MeV electrons and 1-MeV protons in air and in vacuum. Total fluxes ranged from 10^{11} particles/sq cm to 10^{15} particle/sq cm. There was no appreciable degradation in the resistance of the conductive coating during or after these tests. (auth)

18604 (N-73-18675) TESTING OF URANIUM NITRIDE FUEL IN T-111 CLADDING AT 1200K CLADDING TEMPERATURE. Rohal, R. G.; Tambling, T. N.; Smith, R. L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1973. 26p. (NASA-TM-X-2732). NTIS.

Two groups of six fuel pins each were assembled, encapsulated, and irradiated in the Plum Brook Reactor. The fuel pins employed uranium mononitride (UN) in a tantalum alloy clad. The first group of fuel pins was irradiated for 1500 hours to a maximum burnup of 0.7 at. % uranium. The second group of fuel pins was irradiated for about 3000 hours to a maximum burnup of 1.0 at. % uranium. The average clad surface temperature during irradiation of both groups of fuel pins was ~1200°K. Postirradiation examination revealed the following: no clad failures or fuel swelling occurred; less than 1% of the fission gases escaped from the fuel; and the clad of the first group of fuel pins experienced clad embrittlement whereas the second group, which had modified assembly and fabrication procedures to minimize contamination, had a ductile clad after irradiation. (auth)

18605 (N-73-18677) RESULTS OF URANIUM DIOXIDE/TUNGSTEN IRRADIATION TEST AND POST-TEST EXAMINATION. Collins, J. F.; DeBogdan, C. E.; Dilanni, D. C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1973. 77p. (NASA-TM-X-2709). NTIS.

A uranium dioxide fueled capsule was fabricated and irradiated in the NASA Plum Brook Reactor Facility. The capsule consisted of two bulk UO_2 specimens clad with chemically vapor deposited tungsten (CVD W) 0.762 and 0.1016 cm (0.030 and 0.040 in.) thick, respectively. The second specimen with 0.1016- cm (0.040-in.) thick cladding was irradiated at temperature for 2607 hours, corresponding to an average burnup of 1.516×10^{20} power fissions/cm^3. Postirradiation examination showed distortion in the bottom end cap, failure of the weld joint, and fracture of the central vent tube. Diametral growth was 1.3%. No evidence of gross interaction between CVD tungsten or arc-cast tungsten cladding and the UO_2 fuel was observed. Some of the fission gases passed from the fuel cavity to the gas surrounding the fuel specimen via the vent tube and possibly the end-cap weld failure. Whether the UO_2 loss rates through the vent tube were within acceptable limits could not be determined in view of the end-cap weld failure. (auth)

18606 (NRCN-262) BEHAVIOUR OF REFRACTORY MATRICES: OXIDES OF URANIUM, THORIUM, AND ZIRCONIUM IN DC ARC PLASMAS. Avni, R. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev; Weizmann Inst. of Science, Rehovoth (Israel)). Nov 1970. 146p. (In Hebrew). INIS.

Thesis.

A new direct method for spectrochemical analysis of impurities in refractory matrices (uranium, thorium, and zirconium oxides) was developed using a dc arc plasma (graphite electrodes, air, atmospheric pressure). The system and the measuring techniques used are described in detail, and the data obtained are tabulated. The behavior of the various oxides in the discharge is discussed. (INIS)

18607 CREEP OF MIXED-OXIDE FUEL PELLETS AT HIGH STRESS. Routbort, J. L.; Voglewede, J. C. (Argonne National Lab., IL). J. Amer. Ceram. Soc.; 56: No. 6, 330-333(Jun 1973).

The rate of steady-state compressive creep in $(U,Pu)O_{2-x}$ was investigated in the power-law creep region (at a constant stress of 69 MN/m^2 between 1600 and 1500°C) as a function of the oxygen-to-metal (O/M) ratio (1.88 to 1.995). The creep rate over this range is independent of the starting material and decreases with increasing O/M ratio. The apparent activation energy for creep and the preexponential structure factor are sensitive functions of the O/M ratio, with approximately the same dependence on this ratio as these parameters measured at low stresses. These results imply that diffusion of the same defect species controls creep deformation in both the stress-assisted diffusion region ($\dot{\epsilon} \propto \sigma$) and the dislocation-motion region ($\dot{\epsilon} \propto \sigma^{4.4}$). (auth)

18608 DEPOLYMERIZATION OF GeO_2 AND B_2O_3–GeO_2 NETWORK GLASSES BY Sb_2O_3. Riebling, E. F. (Univ. of Akron, OH). J. Amer. Ceram. Soc.; 56: No. 6, 303-309(Jun 1973).

Binary Sb_2O_3–GeO_2 glasses containing ≤45 mol% Sb_2O_3 and ternary Sb_2O_3–B_2O_3–GeO_2 glasses containing ≥50 mol% GeO_2 were prepared. Their densities (volumes), refractive indices, and infrared spectra were determined, and their colors and high-temperature viscosities were estimated visually. Small amounts of Sb_2O_3 (≈10 mol% appear to perturb neither the Ge–O–Ge network nor those B–O–Ge networks with small B/Ge ratios (≈0.2). The B–O–Ge networks with larger B/Ge ratios (≈1.0) depolymerize in the presence of even less Sb_2O_3. Amounts of $Sb_2O_3 > 10$ mol% appear to depolymerize the Ge–O–Ge and Ge–O–B networks progressively, possibly with the formation of chains. A structurally sensitive ir isofrequency contour technique developed for ternary glass systems was applied successfully to these Sb_2O_3–B_2O_3–GeO_2 glasses. These contours can thus readily detect significant network depolymerization in the absence of the usual network modifiers. (auth)

18609 RELAXATION OF VOLUME AND INDEX OF REFRACTION IN PRESSURE-COMPACTED B_2O_3 GLASS. Mizouchi, N.; Cooper, A. R. Jr. (Case Western Reserve Univ., Cleveland). J. Amer. Ceram. Soc.; 56: No. 6, 320-323(Jun 1973).

Relaxation processes were studied in bulk B_2O_3 glasses compacted under hydrostatic pressures up to 21 kbars at room temperature. Measurements of room-temperature density and refractive index at 1 atm revealed that more than one ordering parameter is required to describe observed time-dependent volumetric behavior and that the refractive index is not a single-valued function of density, so that the Lorentz–Lorenz equation must be modified to account for changes in molecular configuration. (auth)

18610 ELASTIC PROPERTIES OF POLYCRYSTALLINE MONOCLINIC Gd_2O_3. Haglund, J. A.; Hunter, O. Jr. (Ames Lab., IA). J. Amer. Ceram. Soc.; 56: No. 6, 327-330(Jun 1973).

The elastic properties of polycrystalline monoclinic Gd_2O_3 were determined by the sonic-resonance method. Volume-fraction porosity varied from 0.025 to 0.367 and temperature from room temperature to 1400°C. The Young's and shear moduli are linear

functions of volume-fraction porosity, but the rate of their decrease with increasing porosity is less than that expected. The moduli decreased more rapidly than expected with increasing temperature. The Debye temperature is 362°K. With increasing temperature, the first Grueneisen constant, γ, decreases, whereas the second Grueneisen constant, δ, increases. (auth)

18611 LIGHT SCATTERING BY PORES IN CERAMIC (Pb,La)$(Zr,Ti)O_3$. Erneta, M.; Stoeckler, H. A. (N L Industries, Inc., Hightstown, NJ). J. Amer. Ceram. Soc.; 56: No. 7, 394-395(Jul 1973).

Results of calculations used in relating the transparency of Pb-doped (Pb, La) $(Zr,Ti)O_3$ with the deviation from theoretical density are presented. It was found that void diameter makes the largest contribution to light scattering, i.e., opaqueness. (JRD)

18612 PHASE RELATIONS IN $(Pb,La)Zr_{0.65}Ti_{0.35}O_3$. O'Bryan, H. M. Jr. (Bell Telephone Labs., Murray Hill, NJ). J. Amer. Ceram. Soc.; 56: No. 7, 385-388(Jul 1973).

Low-temperature phase relations in $(Pb,La)Zr_{0.65}Ti_{0.35}O_3$ ceramics were determined as a function of La content and temperature. Dielectric and piezoelectric measurements and x-ray data were used to locate and identify phase transitions. The FE_1-FE_2 transition between rhombohedral ferroelectric phases occurs at higher temperatures as the La content is increased. For $x > 4$, where x is the atom % La substituted for Pb, a phase region exists between the paraelectric and ferroelectric states. Dielectric data suggest that this region is antiferroelectric. For $6 < x < 9$ a field-induced phase transition accompanies poling. Poled material with $x \approx 8$ exhibits unusual mechanical properties. (auth)

18613 PROPERTIES AND STRUCTURE OF GLASSES IN THE SYSTEMS $M_2O-In_2O_3-GeO_2$ (M = Li, Na, K). Fairweather, M. J.; Murthy, M. K. (Ontario Research Foundation, Sheridan Park). J. Amer. Ceram. Soc.; 56: No. 7, 349-352(Jul 1973).

The glass-forming regions in the ternary systems $M_2O-In_2O_3-GeO_2$ (M = Li, Na, K) were determined. The region in each of the three ternaries is less extensive than in either of the analogous systems $M_2O-Al_2O_3-GeO_2$ and $M_2O-Ga_2O_3-GeO_2$; this behavior reflects the restrictive coordination requirements of the larger In ion. The In_2O_3-containing glasses exhibit higher densities and refractive indices than the corresponding Al_2O_3- and Ga_2O_3-containing glasses. Refractive index and density maximums are observed along lines of constant In_2O_3 in each of the three alkali indogermanate systems. (auth)

18614 DISLOCATION ETCHANT FOR BERYLLIUM OXIDE. Ehman, M. F.; Austerman, S. B. (Rockwell International, Anaheim, CA). J. Amer. Ceram. Soc.; 56: No. 7, 382-384(Jul 1973).

A hydrochloric acid chemical etchant for BeO was refined and evaluated. The etchant, when used for 20 min at 120°C on chemically polished surfaces, produces distinctive pits at dislocations intersecting the $(000\bar{1})$ and $(10\bar{1}\bar{1})$ surfaces. Correspondence of etch pits and dislocations was inferred by comparing the enlargement of pits with etching time and the constancy of pit density with continued etching. On $\{10\bar{1}0\}$ surfaces, the etchant is not sensitive to sites of defect emergence and hence leaves a relatively flat, featureless surface. The etch rates and activation energies are given for $\{000\bar{1}\}$, $\{10\bar{1}0\}$, and $\{10\bar{1}\bar{1}\}$ surfaces. The reaction mechanism is discussed. (auth)

18615 CRACK HEALING IN UO_2. Roberts, J. T. A.; Wrona, B. J. (Argonne National Lab., IL). J. Amer. Ceram. Soc.; 56: No. 6, 297-299(Jun 1973).

Isothermal annealing of thermally shocked UO_2 bars ($O/M = 2.00 \pm 0.01$) at 1600, 1800, and 2000°C caused crack healing, which was determined from recovery of room-temperature fracture strength. The activation energy for crack healing was ≈0.5 of that for volume diffusion, and healing occurred at the same rate as grain growth. This result has important implications with respect to crack healing in oxide fuels during in-reactor restructuring. (auth)

18616 METASTABLE PHASES IN DILUTE ALLOYS OF VANADIUM WITH NITROGEN. Epstein, H.; Goldstein, B.; Potter, D. (Union College, Schenectady, NY). Scr. Met.; 7: No. 7, 717-720 (Jul 1973).

Phase studies of dilute alloys of V with N using aging temperatures between 350 and 600°C are presented. As metastable phases were found to form and disappear, different aging times between 1 and 100 h were used to follow the decomposition of the supersaturated α-solid solution. The resulting structures were investigated using transmission electron microscopy and x-ray diffraction. Results are presented in a schematic lattice drawing and are discussed. (JRD)

18617 YIELD-POINT PHENOMENON IN COMPOSITES. Khan, T.; Rabinovitch, M.; Stohr, J. F.; Trottier, J. P.; Bibring, H. (ORNEA, Chatillon, France). Scr. Met.; 7: No. 7, 727-730(Jul 1973).

Results show that directionally solidified Co-, Ni-, or Fe-base–transition-metal-carbide reinforced composites exhibit a yield point phenomenon associated with the formation of a Lüders band at all test temperatures. The yield-point phenomenon is associated with the rupture of fibers owing to stress concentrations exerted by dislocation pile-ups. The deformation takes place primarily in the matrix and not in the fibers. On the contrary, others found earlier that in synthetic Be–Al (or Fe–Cu) composites, the individual filaments of Be (or Fe) also exhibit a yield point and both phases seem to deform in a cooperative manner. (JRD)

18618 HEAT CONTENT AND HEAT CAPACITY OF ZIRCONIUM CARBIDE AS FUNCTION OF TEMPERATURE AND CARBON CONTENT. Negrych, J. A. Seattle; Univ. of Washington (1973). 55p. University Microfilms Order No. 73-13,870.

Thesis (Ph. D.).

The heat contents of three carbides, $ZrC_{0.95}$, $ZrC_{0.74}$, and $ZrC_{0.58}$ (spanning the range of stability for the compound ZrC_x) were determined from 300 to 1800°K using a diphenyl ether, isothermal drop calorimeter. The heat content data were fitted to polynomials using the method of Shomate and the specific heats, standard entropys, and free energy functions were calculated using the resulting equations. The enthalpies of $ZrC_{0.95}$, $ZrC_{0.74}$, and $ZrC_{0.58}$ can be described by the equations $ZrC_{0.95}$: $11.39T + 0.00052T^2 + (243{,}000/T) - 4256$, $ZrC_{0.74}$: $10.20T + 0.00068T^2 + (225{,}000/T) - 3855$, and $ZrC_{0.58}$: $9.62T + 0.000693T^2 + (207{,}000/T) - 3623$. The data for the carbon saturated carbide compares with the data of other workers to within less than 1%. Specific heats calculated by the Neumann–Kopp rule, the Debye model, and from a model based on an extension of Kaufman and Clougherty's analysis of nonstoichiometric materials predict the experimental specific heats to within experimental error. (Diss. Abstr. Int., B)

18619 RADIATION DAMAGE FOLLOWING COULOMB EXCITATION IN TUNGSTEN COMPOUNDS. Wender, S. A. Iowa City, IA; Univ. of Iowa (1972). 169p. University Microfilms Order No. 73-13,603.

Thesis (Ph. D.).

The effect of irradiation upon WC, WB, W_2B, W_2B_5, WO_3 and WS_2 was studied by observing the Moessbauer effect following Coulomb excitation. The first excited states of ^{182}W, ^{184}W, ^{186}W, and ^{183}W were Coulomb excited using 6.0 MeV alpha particles. Targets and absorbers were maintained at approximately 20°K with a closed-cycle helium refrigeration. Values for the recoilless fraction, hyperfine interaction, and linewidth were determined in the non-irradiated materials using a tungsten metal target with tungsten compound absorbers. These parameters were compared with those obtained by observing the Moessbauer effect using tungsten compound targets and tungsten metal absorbers. In all cases, anomalous hyperfine interaction was observed in the irradiated compound. The recoilless fraction was found to be reduced in many of the materials. In WO_3 it was found that the fractional reduction in recoilless fraction does not depend on the γ-ray energy and is time independent. The data can be understood in terms of local amorphization following irradiation. (Diss. Abstr. Int., B)

18620 THORIA–YTTRIA-BASED CERAMIC MATERIALS. Anderson, R. C. (to General Electric Co.). U. S. Patent 3,737,331. 5 Jun 1973. Filed date 26 Mar 1971. 4p.

High density thoria-based ceramic materials are provided consisting essentially in mole percent as calculated from the batch on the oxide basis of 78 to 96% ThO_2, 2 to 20% Y_2O_3 and 0.5 to 5.0% CaO. These materials may be prepared by pressing the mixed powders and sintering them in a hydrogen atmosphere until about theoretical density is obtained. (Official Gazette)

18621 FUEL ELEMENT FOR HIGH-TEMPERATURE REACTOR. Rachor, L.; Hackstein, K. G. (to Nukem Nuklear-Chemie und Metallurgie GmbH). U. S. Patent 3,738,912. 12 Jun 1973. Filed date 10 Sep 1969. 4p.

There is provided a fuel element for high-temperature reactors comprising a fuel body and a structural graphite body surrounding the fuel body and spaced therefrom. A flange is placed on either the fuel body or the graphite body extending part way through the space to provide for possible relative changes in dimensions of the fuel body and the graphite body. (Official Gazette)

18622 APPARATUS FOR PRODUCING UO_2 POWDER. McCoy, J. J. (to General Electric Co.). U. S. Patent 3,734,694. 22 May 1973. Filed date 2 Dec 1969. 6p.

The design is given for an improved apparatus for preparing uranium dioxide powder suitable for use in the fabrication of fuel for nuclear reactors. The apparatus has a hopper for receiving dewatered sludge, a mixing means within the hopper to maintain

a uniform slurry in the hopper, means for receiving the slurry from the hopper and feeding the slurry through at least one outlet, and a rotating tube calciner adapted to be maintained at a temperature in excess of 1000°F with the outlet positioned at about the center of the calciner circumference adjacent to one end. (auth)

18623 NUCLEAR MAGNETIC RESONANCE OF ^{11}B AT THE THREE BORON SITES IN RARE-EARTH TETRABORIDES. Creyghton, J. H. N.; Locher, P. R.; Buschow, K. H. J. (Philips Research Laboratories, Eindhoven, The Netherlands). Phys. Rev. B 7: No. 11, 4829-4843 (1 June 1973).

An experimental study has been made of the ^{11}B Knight shift at the three different crystallographic boron sites in polycrystalline NdB_4. The three central transitions strongly overlap and cannot be analyzed, but it was possible to derive three different Knight shifts [+0.33(3), +0.26(4), and +0.23(3) % at 77 K for the sites 4e, 8j, and 4h, respectively, uncorrected for pseudocontact and demagnetization fields] from the satellites, which are separate from each other by their different quadrupole interactions [ν_Q=420(6) kHz and η=0 for site 4e, ν_Q=443(10) kHz and η=0.51(2) for site 8j, and ν_Q=622(6) kHz and η<0.05 for site 4h, at both 296 and 77 K]. A detailed account is given of the method of extracting the various shift and quadrupole parameters from the powder satellite spectra. We first analyzed LaB_4, in which the shifts are zero (±0.02%) with respect to $Na_2B_2O_4$ and in which the quadrupole interactions are ν_Q=343(4) kHz and η=0 for 4e, ν_Q=412(4) kHz and η=0.53(1) for 8j, and ν_Q=544(4) kHz and η=0.045(20) for 4h (4-300 K). In NdB_4, relatively large anisotropic contributions to the shifts are found to originate mainly from dipolar fields due to the rare-earth magnetic moments. After correction for pseudocontanct shifts, the isotropic hyperfine fields at boron per unit spin S are about -2 kG. Preliminary measurements on GdB_4 and HoB_4 give the same sign for this field. An attempt is made to fit the observed isotropic shifts in NdB_4 within the Ruderman-Kittel-Kasuya-Yosida scheme. (auth)

18624 RESONANCE PROPERTIES OF ER^{3+} IN THORIUM OXIDE. Choh, Sung Ho; Seidel, G. (Physics Department, Brown University, Providence, Rhode Island 02912). Phys. Rev. B 7: No. 11, 5011-5013 (1 June 1973).

An electron-spin-resonance study at 35 GHz of Er^{3+} in ThO_2 has distinguished three types of erbium sites, one having cubic symmetry and the other two having g values with axial symmetry about a [111] crystallographic axis. Perturbation calculations based on a point-charge model suggest that the axial g values result from the presence of an interstitial charge, in one case positive and in the other case negative, located in an oxygen cube of the ThO_2 lattice, adjacent to the site of the Er^{3+} along the [111] axis. (auth)

18625 PREPARATION AND MECHANICAL PROPERTIES OF COMPOSITES OF FUSED SiO_2 AND W FIBERS. Dungan, R. H.; Gilbert, J. A.; Smith, J. C. (Sandia Labs., Albuquerque, NM). J. Amer. Ceram. Soc.; 56: No. 6, 345(Jun 1973).

The mechanical strength of composites of fused SiO_2 and W fibers prepared by a hot-pressing process is described. The process incorporates a die made of the Mo-alloy TZM and graphitic liners to facilitate hot ejection. The best specimens are obtained by dry-mixing W fibers 0.001 in. in dia and 0.2-in. long with colloidal SiO_2. This mixture is vacuum hot pressed at 1225°C for ~1 h at 28,500 psi. (JRD)

18626 THERMAL RADIATIVE PROPERTIES: COATINGS. Touloukian, Y. S.; DeWitt, D. P.; Hernicz, R. S. TPRC Data Series. Thermophysical Properties of Matter, Volume 9. New York; Plenum Publishing Corporation (1972). 1507p. $100.00.

Numerical data and other information compiled over the years are presented on coatings for all applications, particularly thermal control. The data and information are contained in sections on theory, estimation, and measurement; numerical data; and tabular material index. (JRD)

18627 HYDROLYSIS OF ZIRCONIUM NITRIDES AND CARBIDES. Kyo, B. (Kinki Univ., Osaka); Uchida, K.; Imoto, S. J. Jap. Inst. Metals; 37: No. 4, 411-416(Apr 1973). (In Japanese).

The hydrolytic reactions of zirconium mononitride and monocarbide by superheated steam were studied. In the case of ZrN, the products were found to be H_2, N_2, and NH_3, with a small amount of NO. The amount of NH_3 reached a maximum at 700°C in isothermal reactions; at higher temperatures NH_3 was gradually replaced by N_2. Compared with the hydrolysis of TiN, it is characterized by the formation of a larger amount of NH_3, probably due to the lower reaction temperature for ZrN. The reaction mechanism of ZrN can be represented by an equation similar to that of TiN. In the hydrolysis of ZrC, CO_2, CO, H_2, and a small amount of CH_4 were produced. The amount of CO_2 was maximum at 700°C and more CO was evolved with increasing temperature. X-ray analysis revealed that the hydrolyzed product consisted of metastable tetragonal ZrO_2 at temperatures lower than 700°C and monoclinic ZrO_2 at temperatures higher than 800°C. The reaction equation for the hydrolysis of ZrC was also estimated. CO_2 was found to be produced accompanying equal moles of H_2 at the later stage of the hydrolysis of ZrC as in the case of TiC. The supposition made for the case of TiC that the formation of CO_2 and H_2 in nearly equal moles could be attributed to the steam gas reaction involving CO in the solid residue was confirmed by the measurement of weight loss after re-hydrolysis and by x-ray diffraction technique. The amount of CO contained in the solid residue was larger than that for TiC. (auth)

18628 SOME INVESTIGATIONS ON THE U-C-N PHASE DIAGRAM ABOVE 1700°C. Naoumidis, A.; Katsura, M.; Nickel, H. (Kernforsschungsanlage, Juelich, Ger.). pp 265-275 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

It is easier to produce stoichiometric uranium monocarbonitrides than the equivalent uranium carbides. This advantage is very important when these substances are used in conjunction with the corresponding plutonium compounds as nuclear fuels in fast sodium-cooled reactors. During the manufacture of U(C,N) compounds at temperatures above 1800°C, some important problems must be taken into consideration: with increasing temperature, the univariant point in the U-C-N system is shifted toward the UN composition and thus the compatibility of U(C,N) solid solutions with carbon is limited to a small range of compositions; when temperatures above 1800°C are considered, the UC-rich U(C,N) solid solutions can form hyperstoichiometric compounds by reaction with nitrogen from the gaseous phase (as a result of the cooling process undergone by these phases, UC_2 precipitations prohibit the use of this fuel in metallic claddings); at temperatures in excess of 1900°C, and under reduced N_2 pressure, carbon losses occur as a result of long processing periods in tungsten or molybdenum crucibles (these carbon losses probably being due to the formation of CN radicals); the quenched UC_2 phase has a limited nitrogen solubility even at room temperature (the nitrogen is probably dissolved in the lattice instead of C or C-C groups). (FR)

18629 RARE EARTH HEXABORIDES. The Boron-Scandium System. Etourneau, J.; Mercurio, J. P.; Naslain, R.; Hagenmuller, P. (Bordeaux Univ., Talence, France). pp 429-438 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The hexaborides of rare earth metals were prepared by the borothermal reduction of the corresponding oxides. The parameters affecting the reducing reaction are specified together with the reaction mechanisms occurring in the formation of the hexaborides. Thermal stability studies enabled the hexaborides to be classified into three groups according to their sublimation and dissociation behavior. Controversies concerning the boron-scandium system were resolved. Borothermal reduction studies of Sc_2O_3 over a wide range of temperatures (1200 to 2200°C) and investigations of the different compositions ($2 \leq B/Sc \leq 100$) led to the isolation of three phases: ScB_2, ScB_{12}, and a solid solution of scandium in rhombohedral β boron. All attempts to prepare either scandium tetraboride or scandium hexaboride resulted in a mixture of ScB_2 and ScB_{12}. (FR)

18630 IMPROVEMENTS IN THE MANUFACTURE OF MICROSPHERES BY GEL PRECIPITATION METHODS. Lane, E. S. (to United Kingdom Atomic Energy Authority). British Patent 1,313,750. 18 Apr 1973. Filed date 10 Oct 1969. 4p.

An improved process is described for the manufacture of microspheres, such as those of UO_2 or mixtures of UO_2 with other metal oxides, by the gel precipitation method. In such processes it was found that the addition of certain water-soluble compounds (modifiers) to the mixture of metal salts and gelating agent is beneficial in that the viscosity and surface tension of the mixture can be adjusted so as to improve the sphericity of the product. An aqueous feed solution containing the metal salt or oxide, a gelating agent consisting of a water-soluble organic polymer, and a modifier consisting of an ammonium salt and formamide is introduced in the form of drops into an aqueous alkaline solution so that the drops are converted into solid gel microspheres. The use of modifiers is also beneficial in that the yield of uncracked microspheres is increased, and their surface finish is also improved; also their strength is increased so that they are sufficiently strong

to withstand boiling in water, followed by air drying in a roller drier, prior to being calcined. NH_4NO_3 is a suitable modifier for use with $UO_2(NO_3)_2$ solutions, but ammonium acetate, sulphate, lactate or chloride may be used. Formamide is also often a suitable modifier since many of the polymeric hydroxylic compounds used as gelating agents, such as starch and its derivatives, are soluble in formamide–water systems without a deleterious increase in viscosity. Formamide is also sufficiently stable for use in nitrate systems without causing premature gelation due to release of hydrolysed ammonia during prolonged storage. It may also be beneficial to add C to the feed solution before precipitation when microspheres of carbide or nitride are required. Examples of the process are described. (UK)

18631 GRAIN GROWTH OF SINTERED URANIUM DIOXIDE AT TEMPERATURES OF BETWEEN 1700 AND 2200°C. Landspersky, H. (Ustav Jaderneho Vyzkumu, Rez, Czech.). Pokroky Praskove Met. VUPM; No. 1, 19-29(1972). (In Czech).

Various theoretical and empirical equations proposed for evaluating the grain growth were compared in a series of sintered UO_2 samples heat treated at temperatures between 1700 and 2200°C. (auth)

18632 PARTICLES, POWDERS, AND CRYSTALLITES: THEIR CHARACTERISATION FOR FABRICATION. Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Metals Aust.; 5: No. 4, 127-133(May 1973).

The relationship between the definition of a particle, the characterisation technique and the process in which the powder is used are described with particular reference to oxides of beryllium, thorium, and uranium. In addition, the interaction between powder properties, fabrication processes and the properties of the fabricated article is considered. The characterisation of submicron powders is discussed. (AT)

18633 METHOD OF BRAZING. Heap, H. R.; Riley, C. C. (to English Electric Co., Ltd.). British Patent 1,315,319. 2 May 1973. Filed date 11 Sep 1970. 3p.

A method is described for brazing together bodies composed of SiC, and particularly so-called "structural" SiC, consisting of dense self-bonded SiC containing free Si. The brazing material consists of an alloy of Si with one or more metals. The alloy should contain at least 5 at. % of Si, have a melting temperature not higher than 1400°C, together with thermal expansion characteristics substantially matching those of the SiC, and in the molten state should be capable of wetting the SiC. The alloying metals may be Ge, Fe, Au, Ni, Pd, Pt, Cr, or Ti, and the alloy may be employed in the form of foil or powder. Examples are given. (UK)

18634 SUBSTRUCTURE OF THE WURTZITE-LIKE MODIFICATION OF BORON NITRIDE. Kurdyumov, A. V.; Ostrovskaya, N. F.; Pilyankevich, A. N.; Frantsevich, I. N. (Inst. of Problems in Materials Science, Kiev). Dokl. Akad. Nauk SSSR; 209: No. 5, 1081-1083(11 Apr 1973). (In Russian).

X-ray analysis, electron microscopy, and microdiffraction were utilized to elucidate the structure of the wurtzite-like modification of BN. The model proposed was comprised of particles 3500 Å in diameter consisting of grains (average 500 Å) oriented chiefly in the [001] direction, normal to the particle surface, and developed at an angle of 1 to 5° with respect to each other. The grain contained a region of coherent scattering 150 Å in size. (KSW)

18635 ELECTRIC CONDUCTIVITY OF RARE EARTH ELEMENT OXIDES. Neuimin, A. D.; Balakireva, V. B.; Pal'guev, S. F. (Inst. of Electrochemistry, Sverdlovsk, USSR). Dokl. Akad. Nauk SSSR; 209: No. 5, 1150-1153(11 Apr 1973). (In Russian).

Measurements were made of the electric conductivity of 99.9% pure oxides of Nd, Sm, Eu, Gd, Dy, Ho, Er, Yb, Lu, Y, and Sc over the temperature range 400 to 1200°C. The majority of these oxides proved to be semiconductors; only in the cases of Sm_2O_3, Eu_2O_3, and Gd_2O_3 at the lower temperatures did the ion transfer numbers attain significant values. (KSW)

18636 FORMATION OF WC–TiC SOLID SOLUTIONS. Tikkanen, M. H.; Sipila, J. (Inst. of Tech., Otaniemi, Finland). Phys. Sintering; 5: No. 2, 67-78(May 1973).

The diffusion mechanism during the formation of (Ti, W) C solid solution was investigated by means of a scanning electron microscope and an energy-dispersive x-ray microanalyzer connected with it. All the diffusion annealings at 2400°C up to 4 hours were made in an induction furnace with graphite crucibles. It was concluded that the formation rate of the solid solution depended on the diffusion rate of W atoms in the TiC lattice and, further, that O atoms in the TiC lattice strongly retarded the W diffusion process. (auth)

18637 COMPRESSIBILITY OF UO_2 MICROSPHERES. Gondi, P. (Univ., Bologna); Granata, S.; Patuelli, C.; Tognato, R. Energ. Nucl. (Milan); 20: No. 7, 406-416(Jul 1973).

Optical and electron microscopy observations were carried out together with hardness and compression tests on microspheres, 700 μm in diameter, of sintered UO_2 with apparent densities in the range from 9.5 to 10.8 g/cm^3. The obtained compressibility values of the specimens are interpreted in terms of microsphere structure as composed of compact shells and porous cores. Porosity influences fracture loads and strains mainly indirectly, through the shell thickness dependence on the porosity itself. (13 figures) (auth)

18638 TEMPERATURE DEPENDENCE OF MICROHARDNESS OF THE TRANSITION-METAL CARBIDES. Kohlstedt, D. L. (Cambridge Univ., Eng.). J. Mater. Sci.; 8: No. 6, 777-786(Jun 1973).

Microhardness as a function of temperature has been measured for single crystals of $TiC_{0.96}$, $ZrC_{0.94}$, and $NbC_{0.87}$ from room temperature through their ductile-brittle transitions and for single crystals of V_6C_5 through the order-disorder transition. The present data confirm the result observed for polycrystalline specimens that for $T < 0.5\ T_m$, the decrease in hardness with increasing temperature for the carbides is substantially more rapid than for metals and semiconductors. Above the ductile-brittle transitions, the ratios of hardness to yield stress are factors of 1.5 to 3 larger than calculated from theory. It is suggested that the larger values result from the higher strain-rates and larger strains involved in the hardness tests. Arrhenius plots of the hardness data for $T > 0.25\ T_m$ are linear and exhibit changes in slope near 0.33 and 0.44 T_m. The former temperature is near the ductile-brittle transition temperature for the disordered carbides, and the latter is at the temperature for which a similar change in Arrhenius slope occurs in published yield-stress data. In addition, a change in slope is found for VC at 0.48 T_m (1275°C) which is the order-disorder transition temperature for $V_6C_5 \rightarrow VC_{0.84}$. These changes in slope are suggestive of corresponding changes in the thermally activated processes governing plastic flow. (auth)

18639 OPTICAL ABSORPTION IN CURRENT-BLACKENED YTTRIA STABILIZED ZIRCONIA. Wright, D. A.; Thorp, J. S.; Aypar, A.; Buckley, H. P. (Univ. of Durham, Eng.). J. Mater. Sci.; 8: No. 6, 876-882(Jun 1973).

The nature of the blackening caused by high-temperature (800°C) electrolysis of 8 and 12 mol% yttria-stabilized zirconia single crystals has been investigated by studying the optical absorption between 260 and 700 nm. In the early stages the band edge remained at 271 nm, the crystal became red and the transmission showed a broad minimum centered at 480 nm; in the later stages the crystal became black and the transmission was reduced drastically over the whole visible range. The low transmission was shown, by integrating sphere measurements, to be due to absorbing centers. These were attributed to the formation of vacancy aggregates which ultimately produced colloidal metallic particles. (auth)

18640 THERMODYNAMIC BEHAVIOR OF (U, Pu) MIXED-OXIDE FUELS. Javed, N. A. (Argonne National Lab., IL). J. Nucl. Mater.; 47: No. 3, 336-344(Jul 1973).

Transpiration experiments were performed at temperatures between 1000 and 1700°C to study the thermodynamics and defect structure of hypostoichiometric UO_2–20 wt % PuO_2 solid-solution systems. The oxygen partial pressures were established by using flowing H_2H_2O mixtures. After equilibration, the quenched products were analyzed by chemical, x-ray neutron-diffraction, and metallographic techniques. The $\Delta\bar{G}_{O_2}$ versus temperature curves for the mixed oxide with different oxygen-to-metal ratios were plotted. Based on x-ray, neutron-diffraction, and metallographic data, it was concluded that the 20 wt % PuO_2 mixed oxide exists as a single phase under normal conditions, even at an oxygen-to-metal ratio as low as 1.92. The data from density measurements and neutron-diffraction analysis indicated that the predominant defects in the hypostoichiometric UO_2–20 wt % PuO_2 are anion vacancies. (5 figures, 14 references) (auth)

18641 BAINITIC TRANSFORMATIONS IN URANIUM CARBIDES. Ashbee, K. H. G. (Univ. of Bristol, Eng.); Frank, F. C.; DuBose, C. K. H. J. Nucl. Mater.; 47: No. 3, 323-335 (Jul 1973).

In view of the high-temperature solid solution that exists from the approximate composition UC to the approximate composition UC_2, a new nomenclature is suggested for the carbide phases of

uranium. As far as the uranium atoms are concerned, there are very close relationships between these phases and models are examined for the "military transformations" that are believed to occur in them. It is assumed that the carbon diffusion also required by these transformations, including the interchange of single carbon atoms for double carbon atoms, is easy. The bainitic transformations thus deduced are used to interpret the microstructures revealed by transmission electron microscopy of three uranium–carbon alloys. (9 figures) (auth)

18642 RELEASE OF ^{133}Xe FROM LIGHTLY IRRADIATED UC_xN_{1-x}. Iseki, T. (Tokyo Inst. of Tech.); Hase, T.; Suzuki, H.; Kimura, S.; Tamai, T. Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 116, 91-95(Mar 1973).

UC and UN have higher metallic density and higher thermal conductivity, compared with oxide fuel. It makes them potential fuels. But high swelling rate of UC, the appreciable cross section of nitrogen for thermal neutrons, and the thermal decomposition of UN over 2,000°C have discouraged extensive development. In order to correct these defects, uranium carbonnitride, UC_xN_{1-x}, a solid solution of UC and UN, is regarded as an attractive fuel. Many reports have been published with Xe release from edge compositions UC and UN, though the results are scattered. However, only a few studies have been reported with the Xe release from UC_xN_{1-x}. In the present report, the behavior of ^{133}Xe release from lightly irradiated UC_xN_{1-x}, changing x from 0.36 to 0.81, was investigated by post-irradiation annealing. (auth)

18643 RELEASE RESTRAINT IN NEUTRON-IRRADIATED BeO SINTERED BODIES: BeO AS MODEL SUBSTANCE FOR INVESTIGATION OF IRRADIATION-INDUCED DIFFUSION PROCESSES. Stoever, D.; Fischer, P. G.; Roehrig, H. D. (Institut fuer Reaktorentwicklung, Juelich, Ger.). J. Nucl. Mater.; 47: No. 3, 317-322(Jul 1973). (In German).

Results are presented on gas diffusion in ceramic material irradiated to high doses. The samples were BeO sintered bodies, and both the original and the as-irradiated mechanical properties were precisely characterized. The transport behavior, during post irradiation annealing, of the helium formed during irradiation was investigated. Helium liberation cannot be expressed in terms of simple Fick diffusion theory. Anomalies in gas release above about 1100°C are attributed to several independently coexisting lattice defects. The rate of release for this temperature range can therefore be described in terms of cooperating diffusion mechanisms with four distinct activation energies: q_1 = 9.4 eV/atom, q_2 = 4.6 eV atom, q_3 = 3.4 eV/atom, q_4 = 1.8 eV/atom. The ultrasensitive measuring technique depends on a dynamic measurement of partial pressures. The precise characterization of the samples permits correlation between mechanical properties and diffusion kinetics. Below 1100°C, structural recovery processes dominate and determine the rate of gas release. Part of the helium remains firmly fixed in bubbles and cannot be removed by heat treatment. (5 figures) (auth)

18644 MICROPROBE INVESTIGATIONS OF IRRADIATED URANIUM CARBIDE. Kleykamp, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 47: No. 3, 271-277(Jul 1973). (In German).

A shielded Cameca microprobe, MS 46, was used to examine a UC sample canned in SAP and irradiated to a burnup of 0.7%. An annular zone at about 40% of the outer sample radius was seen to contain precipitates loaded with fission products; microprobe analysis showed the precipitates to be $U_2(Tc,Ru,Rh)C_2$. Small amounts of palladium can be stabilized in this phase. Zirconium and molybdenum were verified in homogeneous distribution in the fuel. The Vickers hardness of the irradiated UC is 1000 to 1200 kp/mm^2. No signs of incompatibility with the canning material were detected. (4 figures, 22 references) (auth)

18645 EFFECT OF γ RADIATION ON THE DEFORMATION OF UO_2. Solomon, A. A. (Argonne National Lab., IL); Davis, M. V. J. Nucl. Mater.; 47: No. 3, 345-346(Jul 1973).

To determine whether γ radiation produces measurable creep in oxide fuels, UO_2 helices were creep tested in a ^{60}Co facility at an intensity of 1.65×10^7 R/h, up to 90 h. Specimen temperatures were estimated to have increased 20°C from the ambient 80°C as a result of γ heating. No deflection was detected. (DLC)

18646 STRUCTURE AND PROPERTIES OF C–B–Fe HARD FACING ALLOYS. Levitskii, S. N. (Scientific-Research Inst. of Petroleum Machine Construction, Baku). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 7-8, 637-639(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 7, 70-72(Jul 1972).

The structure and properties of iron-base C–B–Fe hard facing alloys were studied. It was found that electrospark facing with powder-metallurgy wire containing boron carbide in the core produces surfaces with a high boron content. A high concentration of boron and carbon in iron-base alloys permits the formation of a substantial amount of finely dispersed precipitates of resistant and refractory borides and carbides. The high-boron alloy of the C–B–Fe system has a good combination of properties suitable for the operating conditions of petroleum equipment. (JRD)

18647 USING INCREASED FABRICATION PRESSURES FOR MAKING ARTICLES FROM CERTAIN ELECTROFUSED HIGHLY REFRACTORY MATERIALS. Balkevich, V. L.; Surkova, I. A.; Korshunov, V. S.; Sturman, V. K. (Inst. of Chemical Tech., Moscow). Refractories (USSR) (Engl. Transl.); 13: No. 5-6, 398-401(1972).

Translated from Ogneupory; 13: No. 6, 49-53(Jun 1972).

The porosity of refractories made from fused Mgo–Al_2O_3–ZrO_2 can be greatly reduced (to 10 to 13%) by using increased fabrication pressures and coarse-grained bodies with low quantities of finely milled bond (10 to 15%). The densification mechanism in the coarse-grained bodies consists in breaking up the large grains and redistributing them. The requirement for maximum density of packing in selecting the grain-size composition of the bodies is of first rate importance. The maximum fabrication pressure should not exceed the values at which the critical density is reached. (auth)

18648 PRODUCTION AND SERVICE TESTING OF THERMOCOUPLE SHEATHS BASED ON AlN–Al_2O_3–Mo. Garibyan, F. S.; Trunov, G. V. Refractories (USSR) (Engl. Transl.); 13: No. 5-6, 383-385(1972).

Translated from Ogneupory; 13: No. 6, 36-38(Jun 1972).

A study was made of the relationship between the content of bond required for obtaining isoviscous slips and the composition of the materials in the system AlN–Al_2O_3–Mo. This relationship for slips of moderate viscosity is linear. It is shown that the optimum volume concentration of the bond for the systems investigated is 30 to 33%. To obtain products of high quality the heating employed to remove the bond should be done at a rate change of no more than 15 deg/h in hydrogen. By sintering the castings from thermal-plastic slips it is possible to obtain products with a porosity of up to 10 to 12%. The tests carried out in a converter showed that the sheaths containing 20% (mol.) AlN and 80% Al_2O_3 with an addition of 5% (at.) Mo can be used for continuous measurement of steel temperatures for 80 min. (auth)

18649 IMPROVING THE PRODUCTION OF ZIRCON NOZZLES FOR CONTINUOUS STEEL-CASTING PLANT. Danchuk, I. M.; Bogoslovskaya, L. N. Refractories (USSR) (Engl. Transl.); 13: No. 5-6, 281-283(1972).

Translated from Ogneupory; 13: No. 5, 1-4(May 1972).

The use of zircon concentrate of original grain-size distribution for making nozzles reduces the dust concentration at the work sites, conferring a higher apparent density on the green briquette. The briquette can be much better pressed, which increases the output of the press. The loss of nozzles is halved. The properties of the finished goods correspond to the technical specifications. The zircon nozzles ensure four or more castings in service, instead of a single casting through a nozzle. A saving effect from using zircon concentrate of the original grain size was realized. (auth)

18650 KINETICS OF THE ALLOTROPIC α–β TRANSFORMATION IN ZIRCONIUM OF VARIOUS DEGREES OF PURITY. Garber, R. I.; Kharitonova, Zh. F.; Azhazha, V. M.; V'yugov, P. N.; Belikodnaya, O. A. (Physical-Technical Inst., Kharkov). Fiz. Metal. Metalloved.; 35: No. 4, 863-865(1973). (In Russian).

The mechanism and kinetics of crystal growth were studied in connection with the $\alpha \rightarrow \beta$ transformation in Zr of 99.7 wt. % purity. Changes in the amplitude of twisting oscillation with time for different initial amplitudes were used to interpret the mechanism of the phase conversion. Iodide Zr and Zr purified by zone melting were compared in these experiments. (KSW)

18651 WEAR RESISTANCE OF SURFACING ALLOYS IN HYDROABRASIVE WEAR. Levitskii, S. N.; Kasumzade, N. G. Vestn. Mashinostr.; No. 2, 32-34(Feb 1973). (In Russian).

Results are presented from studies of wear resistance of a group of widely used surfacing materials and new alloys in the C–B–Fe and C–W–Fe alloy systems. Wear-resistant surfacing materials are found which effectively increase the durability of oil field equipment parts. The most effective alloys are U13R12S2G3 (1.3% C, 2.2% Si, 3.2% Mn, 12.5% B) and U20V35 (1.9% C, 0.8% Si, 0.6% Mn, 32% W). (JPRS)

18652 SUPERCONDUCTIVITY, NORMAL-STATE-ELECTRICAL, AND STRUCTURAL PROPERTIES OF Nb/Al_2/O_3 CERMET

FILMS. Devenyi, A. (Univ., Karlsruhe, Ger.); Theiner, W.; Sharma, S. K.; Aalfeld, J.; Manaila-Devenyi, R. Thin Solid Films; 15: 39-53(1973).

Nb/Al_2O_3 cermet films were obtained by electron-gun evaporation from two independent sources. Films containing 71 wt. % Nb (particle size about 20 Å) have an activated type of conduction mechanism due to the hopping of the charge carriers between localized states. The activation energy decreases continuously from 8.8×10^{-3} eV (300°K) to 1×10^{-6} eV (1.9°K), which indicates that the localized states lie close to the Fermi level of the system. These states can be associated with small Nb particles (below the resolution power of the electron microscope — 10 Å) in the alumina matrix. Films containing more than 85 wt. % Nb (mean particle size 32 Å) have a metallic-type conduction mechanism and show superconductive properties. The transition temperature is reduced to 4.5 to 5.2°K compared with the Nb bulk value of 9.2°K; this is presumably due to a decrease of the electronic interaction in the surface layer of the Nb particles. (auth)

18653 OUTLINE AND CURRENT RESEARCH STATUS OF COATED-PARTICLE FUELS. Iwamoto, K. (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 15: No. 2, 86-101(Feb 1973). (In Japanese).

In the past few years, great interest has been aroused in the HTGR from the viewpoint of effective use of nuclear energy as well as alleviation of environmental problems in Japan. The coated-particle fuels for the HTGR are described and the current research status on relations between the properties and irradiation behavior of the coated fuel particles is reviewed. (auth)

18654 ANALYSIS OF HIGH-TEMPERATURE PHASE AND TRANSFORMATION DIAGRAMS USING ELECTRICAL MEASUREMENTS. Hoerster, H.; Hauer, E.; Kettel, F. (Philips Forschungslaboratorium GmbH, Aachen). pp 39-46 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

An experimental arrangement for studying the reaction between a tantalum ribbon and methane at 2450°C is given. In this way the Ta–TaC phase diagram was obtained. In the TaC_x region ($0 \leq x \leq 0.7$), the concentration coincides with the time base. The results are discussed taking into consideration published data for the system. Another device enabled rapidly occurring phenomena (down to 10^{-6} s) to be studied and allowed the $\alpha-\beta$ transformation of zirconium and hafnium to be studied. Information was thus obtained on the rate at which the transformation occurred, the heat involved, and the transformation temperature. (FR)

18655 DIFFERENTIAL THERMAL ANALYSIS AT HIGH TEMPERATURES. Kocherzhinskii, Yu. A. (Inst. of Metal Physics, Kiev). pp 47-51 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformation at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

A new differential thermocouple is presented. The apparatus enables differential thermal analysis measurements to be made in an argon atmosphere up to a temperature of 2200°C and sometimes up to 2450°C. Melting thermograms are given for Y_2O_3 (2400°C), Ir (2450°C), and Mo_3Si_3 (2180°C) together with the solid-state phase changes for BeO (2100°C) and $MoSi_2$ (1850°C). The solidification diagrams for the binary system Si–Mo were obtained. (FR)

18656 THERMAL ANALYSIS OF REFRACTORY PRODUCTS. Sibieude, F.; Bonet, C. (CNRS, Montlouis, France). pp 53-56 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformation at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The process and equipment described enable refractory products to be analyzed without limitations concerning their melting points. An example is given: establishment of the existence of allotropic transformations occurring during the solidification of lanthanum oxide and the determination of the temperature corresponding to a change in the crystal structure. In addition, work was conducted on the determination of the solidification point of thoria and the liquidus lines of mixtures containing thoria and lanthanide oxide for thoria-rich molar fractions. It is possible to operate under a controlled atmosphere although the thermal analysis of metallic products is not possible in this way. (FR)

18657 THERMAL ANALYSIS DEVICE FOR THE STUDY OF CRYSTALLINE TRANSFORMATIONS AND PHASE CHANGES AT HIGH TEMPERATURES. Benezech, G.; Berjoan, R.; Coutures, J. P.; Granier, B.; Foex, M.; Mizuno, M. (CNRS, Montlouis, France). pp 57-69 of Paris; Centre National de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformation at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

A thermal analysis apparatus for use in conjunction with a horizontal axis solar furnace is described. The problems of temperature measurement under these conditions are examined and discussed. Ultraviolet, visible, and infrared pyrometers are compared. Thermal analysis curves ($La_2O_3-Cr_2O_3$ and Y_2O_3) obtained with and without solar radiation are given as examples. The effect of the atmosphere on phase changes and crystal transformations was established. (FR)

18658 TRANSMISSION ELECTRON MICROSCOPY OF REFRACTORY MATERIALS APPLIED TO SILICON CARBIDE AND VANADIUM CARBIDE. Van Landuyt, J. (Antwerp Univ., Belgium); Amelinckx, S. pp 87-94 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

In silicon carbide, stacking faults were studied using the direct-imaging technique and also diffraction fringe observations. The displacement vector is deduced and experimental proof obtained of the existence of a more refined structure for the 6H crystal form using electron-diffraction techniques. Studies of vanadium carbide illustrated how electron diffraction can be used to derive the lattice and orientation relations between the β and dzeta phase and the cubic matrix. (FR)

18659 HIGH-ENERGY ELECTRON DIFFRACTION CAMERA FOR THE STUDY OF MATERIALS AT VERY HIGH TEMPERATURES. Burggraf, C.; Goldsztaub, S. (Univ., Strasbourg). pp 95-96 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The development of a high-energy electron-diffraction camera for the study of materials at very high temperatures is discussed. Applications to studies of phase changes in hafnium oxide near 1,800°C are presented. (FR)

18660 DESCRIPTION AND UTILIZATION OF A FURNACE FOR AN X-RAY DIFFRACTOMETER. Fleurence, A.; Lecrivain, L.; Farges, P.; Vignet, J. (Societe Francaise de Ceramique, Paris). pp 103-113 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

A furnace is described that can be used in conjunction with an x-ray diffractometer fitted with a horizontal goniometer and allows mineralogical analyses to be made of solid substances up to 1700°C. The sample is heated by radiation, a U resistor forming a frame around both the back and front faces of the sample holder. This resistor and various parts of the inside of the furnace are made of tantalum. The assembly is cooled by circulating water. Beryllium windows permit the passage of incident and diffracted x-ray beams without significant absorption. Studies were made on zirconia, corundum, and a synthetic mixture (olivine). (FR)

18661 FURNACE FOR X-RAY CRYSTALLOGRAPHY STUDIES AT HIGH TEMPERATURES. Applications to Aeronautics and Astronautics. Guichet, L.; Trillat, J. J. (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Paris). pp 115-127 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

A furnace diffractometer system was chosen for x-ray crystallographic studies of materials at high temperatures. Various considerations render the use of such a system preferable to that

of a photographic camera. The principal characteristics of the device used are described: largeness of the isothermal surface of the sample; radiation heating of the sample; minimization of the contact between the sample and the sample holder (the point of contact being far from the heated sample holder (the point of contact being far from the heated region); possibility of introducing a controlled pressure of neutral gas; possibility of modifying the position of the sample in relation to the goniometric axis at all temperatures. The temperature of the irradiated surface of the sample is measured using optical pyrometry. A special device enabling the emissivity of this surface to be determined is also described. Some applications are given together with the results obtained: study of the stabilization of zirconia with neodymium oxide (for quantities of up to 12.5% Nd_2O_3, the material has the appearance of a mixture, while for a concentration of 30% of Nd_2O_3 the material seems to be essentially neodymium zirconate); measurement of the thermal expansion coefficients (stabilized zirconia and beryllium oxide). (FR)

18662 APPLICATION OF A LASER-HEATING TECHNIQUE IN THE HIGH-TEMPERATURE X-RAY STUDY OF OXIDES. Hanic, F.; Stracelsky, J.; Sumichrast, L. (Univ. of Bratislava). pp 129-132 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

Samples can be heated in air up to a temperature of 3300°C by the absorption of laser radiation. The technique was applied to investigations of phase transformations in ZrO_2 and HfO_2. (FR)

18663 DISCUSSION ON EXPERIMENTAL ASPECTS OF HIGH-TEMPERATURE X-RAY DIFFRACTOMETRY USING HEATED RIBBONS. Traverse, J. P.; Badie, J. M.; Foex, M. (CNRS, Montlouis, France). pp 139-147 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

This method seems to have been the most successful technique utilized during the past decade in the study of high-temperature structure modifications. Although the utilization of the heated ribbon technique presents few difficulties, a certain number of precautions must be taken. Examinations of the experimental conditions demonstrated the usefulness of various techniques currently being developed. This method can still be improved upon; such improvements would enable a refinement and a broadening of the information made available. Some of the results obtained indicate the possibility of working at extreme temperatures. A brief discussion is given on new high-temperature forms of rare earth sesquioxides. (FR)

18664 VACANCY SHORT-RANGE ORDER IN CUBIC $VC_{.75}$. Parthe, E.; Sauvage, M. (Univ., Geneva). pp 181-182 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

Diffuse streaks in the electron-diffraction patterns of single crystals of substoichiometric vanadium carbide are explained in terms of a short-range order of the carbon vacancies. Numerical values of the short-range-order parameters indicate a close structural relation with the known ordered vanadium subcarbide V_8C_5. (FR)

18665 ORDER–DISORDER LAMBDA TRANSITION IN URANIUM DIOXIDE AND OTHER SOLIDS OF THE FLUORITE TYPE OF STRUCTURE. Bredig, M. A. (Oak Ridge National Lab., TN). pp 183-191 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The occurrence of a lambda transition in solid ionic compounds AB_2 having the simple fluorite (or antifluorite) type of crystal structure was established lately through high-temperature calorimetric heat content measurements on $SrCl_2$ and K_2S (Dworkin and Bredig, 1963 to 1968). This and consideration of other properties (electrical conductance, ion self-diffusion) and of the particular geometry of the fluorite structure led to the postulate that the cooperative phenomenon of B ion disordering, essentially complete, i.e., for beyond the formation of merely a limited number of non-interacting Frenkel defects, was a general characteristic of such compounds including refractory dioxides. Correspondingly, this transition is in fact found not only in UO_2 (T_{tr} ~2670°K) as discussed in greater detail, but also in CaF_2, SrF_2, BaF_2, PbF_2, and Na_2O. It is predicted for ThO_2, Na_2S, $Li_2(NH)$ and most other ionic compounds having this type of structure. Correlation of excess entropy with the relative sizes of the A and B ions, i.e., of the characteristics lattice voids and the B ions entering them on disordering, is found, provided a more recent set of ionic crystal radii is used in place of the conventional one. (FR)

18666 ORDER–DISORDER TRANSFORMATION OF Ta_2C. Bowman, A. L.; Krikorian, N. H.; Nereson, N. G.; Rupert, G. N. (Los Alamos Scientific Lab., NM). pp 193-197 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The order-disorder transformation of Ta_2C was studied using high-temperature neutron diffraction and derivative thermal analysis. The transition is from the ordered C6 structure to the random L'3 structure occurring at about 2035° in the presence of tantalum, and at 2010° in the presence of the dzeta phase, with a congruent maximum at approximately 2200° near the stoichiometric composition. (FR)

18667 THERMOELECTRIC EMISSION: METHOD OF INVESTIGATING POINT DEFECTS RESPONSIBLE FOR NONSTOICHIOMETRIC PHASES AT HIGH TEMPERATURES. Loup, J. P. (Daker Univ., Senegal, S. Afr.); Odier, P.; Anthony, A. M. pp 235-239 of Study of Crystalline Transformation at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

It is shown that information on atomic point defects present in oxides at high temperatures can be obtained from a study of thermionic emission. It is found that the current density J is given by the simple relation $\log J = -1/x \log P_{O_2}$ + constant (x is characteristic of the particular type of defect considered). Results indicate a Frenkel-type defect for oxygen in Y_2O_3 and ZrO_2 in the 1300 to 2000°K and 10^{-11} to 10^{-6} atmosphere ranges. The method depends essentially on the fact that the emission is only dependent upon the electron concentration and not on the various charge carrier concentrations as is the case for conduction. The emission isotherms of zirconia enable the oxygen pressure to be determined for which the oxide is stoichiometric. This information is used to deduce the slope of the tangent to the free enthalpy curve of the mixture for the stoichiometric case. The value of this slope is related to the extension of the nonstoichiometric phase $ZrO_{2\pm x}$. The free enthalpy curve is plotted for the Zr–O system. (FR)

18668 PHASE DIAGRAM OF THE Hf–Mo–C SYSTEM STABILIZATION OF MOLYBDENUM CARBIDES WITH TRANSITION METALS. Jeremenko, W. N.; Welikanowa, T. Ja.; Schabanova, S. W.; Artjuch, L. W. (Inst. of Problems in Materials, Kiev). pp 277-292 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In German).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The Hf–Mo–C ternary phase diagram was investigated for all compositions in a temperature range extending from the solidus line up to 1400°C. The projections of the solidus surface were determined together with the isotherm sections at 2000°C, 1700°C, and 1400°C. Molybdenum and hafnium carbides, having the same cubic structure, form (> 1960°C) continuous solid solutions. Hafnium stabilizes the higher molybdenum carbide both in its cubic and hexagonal form. It was established that the intensity of the stabilization effect of transition metals for these carbides diminishes in changing from the IV to the VI column of the periodic table. (FR)

18669 METHOD FOR THE INVESTIGATION OF SURFACE AND VOLUME TRANSFORMATIONS OF A CARBURIZABLE METAL REACTING WITH A GASEOUS HYDROCARBON. Wach, J.; Michel, J. M.; Castro, M. (CNRS, Villers-les-Nancy, France). pp 293-307 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

A metallic ribbon heated by the Joule effect is placed in a reactor in which a hydrocarbon gas is circulated in the Knudsen regime. The decomposition of the hydrocarbon yields hydrogen and carbon which diffuse into the solid. The reaction rate can be determined from measurements of the quantity of hydrogen formed or directly by mass spectrometry. The changes occurring in the electrical resistance of the solid are measured simultaneously. It is shown that the variations in the electrical resistance can be used to determine the nature, composition, and importance of the solid phase formed, and to study transformations, e.g., eutectoid reactions or to measure the absolute rate of reaction. It is also shown that measurements of the shock decomposition of the hydrocarbon enable changes in phase and surface orientation to be studied together with competition between the supply and evaporation of carbon. (FR)

18670 HIGH-TEMPERATURE X-RAY DIFFRACTOMETRY WITH A SOLAR FURNACE. Noguchi, T. (Solar Research Lab., Nagoya, Japan). pp 347-349 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

High-temperature phase transitions, thermal expansion, and other thermophysical properties can be studied using x-ray-diffraction techniques at high temperatures. A 0–0 goniometer was designed for operation in conjunction with a heliostat-type solar furnace to obtain diffraction data for samples heated above 2000°C. Data for ZrO_2 are presented. The measurement and control of the specimen temperature were effected using an infrared pyrometer operating at 2.62 μm. (FR)

18671 HIGH-TEMPERATURE PHASE TRANSFORMATIONS IN SOME LANTHANIDE AND ACTINIDE OXIDES. Chikalla, T. D.; McNeilly, C. E.; Bates, J. L.; Rasmussen, J. J. (Battelle Pacific Northwest Labs., Richland, WA). pp 351-360 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (t)

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The melting behavior of the sesquioxides and dioxides of thorium and curium actinides is reviewed. The melting points of two actinide oxides were determined for the first time: NpO_2 mp = 2560 ± 50°C and Am_2O_3 mp = 2205 ± 15°C. The crystal phase transformations of Cm_2O_3, Pm_2O_3, and Sm_2O_3, which together exhibit five crystal forms, were studied. The phase transformation behavior of these actinide sesquioxides is very similar to that of lanthanide oxides. The thermal stability regions of the different polymorphs in both series correlate well with the trivalent ionic radii. The volume change occurring during the melting of Sm_2O_3 was determined to be 4.3%. The surface tension and expansion properties of liquid Sm_2O_3 were also studied. (FR)

18672 STUDY OF HIGH-TEMPERATURE TRANSFORMATIONS IN RARE EARTH SESQUIOXIDES USING ELECTRON MICROSCOPY AND ELECTRON DIFFRACTION. Boulesteix, C. (Paris Univ., Orsay, France); Caro, P.; Gasgnier, M.; Henry La Blanchetais, C.; Schiffmacher, G. pp 361-367 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

Various rare earth sesquioxide structures were studied using electron diffraction techniques and electron microscopy. The electron bombardment of thin films of these materials enabled the high-temperature phases previously described by M. Foex and J. P. Traverse to be observed. Special emphasis is drawn to the observation of a hexagonal H phase. This new method permitted the appearance of the different phases (C–B, B–A, and B–H transformations) to be studied throughout the entire lanthanide series. It also allowed the characteristics of the transformation to be determined together with information on the reorientation of the new form from the phase in which it originated. (FR)

18673 POLYMORPHISM OF Ln_3NbO_7 COMPOUNDS. Tilloca, G. (CNRS, Vitry-sur-Seine, France); Perez Y Jorna, M.; Traverse, J. P.; Coutures, J. pp 369-373 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The compound Ln_3NbO_7 appears in systems formed between the niobium oxide, $Nb_2O_5\alpha$, and rare earth (Ln = La to Dy) sesquioxides. Various polymorphs are formed depending upon the nature of the lanthanide element included in the compound. When Ln = La, Nd, or Sm, the structures present orthorhombic symmetry (Pnam group) at 1,300°C. Above this temperature, high-temperature x-ray diffraction techniques and examinations of quenched materials revealed a simplified spectrum which corresponds (at least for Sm_3NbO_7) to the appearance of a fluorite cubic form near to the melting point, this form occurring after an intermediate, probably monoclinic state (P2/m space groups). When Ln = Eu or Gd only monoclinic and cubic forms exist between 1300°C and the melting point (1800°C). After dysprosium the fluorite-type cubic form exists at all temperatures. Both the orthorhombic and monoclinic forms of Ln_3NbO_7 are stoichiometric. In contrast, the fluorite-type cubic form presents a certain degree of homogeneity due to dissolution in Ln_2O_3. (FR)

18674 STUDY OF THE EFFECT OF CRYSTAL PHASE CHANGES ON THE DECOMPOSITION MECHANISMS OF RARE EARTH OXIDES USING MASS SPECTROMETRY. Nguyen, L. D.; de Saint Simon, M. (Paris Univ., Orsay, France). pp 375-379 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

In the course of systematic mass spectrometry studies of the decomposition of very small quantities of rare earth oxides, the ratio between the metallic ion (M^+) and monoxide (MO^+) currents, $i(M^+)/i(MO^+)$, arriving at the mass spectrometer collector electrode was determined. In the case of certain elements, the curve representing the variation of $\log_{10} i(M^+)/i(MO^+)$ as a function of $10^4/T$ exhibits a change in slope at a temperature $T_{(c)}$ in the 2000°K region. This phenomenon may be due to changes in the sesquioxides, similar to those observed by Foex and Traverse. (FR)

18675 PHASE CHANGES REVEALED BY VAPORIZATION MEASUREMENTS ON PLUTONIUM CARBIDES AND OXIDES. Marcon, J. P. (CEN, Fontenay-aux-Roses, France). pp 381-386 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

In a binary system, it is possible to construct a p = F(T) diagram with each two-phase domain being represented by a curve. Under such conditions the triple points of the composition–temperature diagram are also triple points on the vapor pressure–temperature diagram. In this way it was possible to study the solid-phase decomposition $2PuC_2 \rightarrow Pu_2C_3 + C$; the peritectic melting of PuC_3 into liquid and PuC_2; the peritectic melting of PuC_2 into liquid and carbon; the solid-phase decomposition of the bcc oxide $PuO_{1.56}$ into hexagonal Pu_2O_3 and fcc $PuO_{1.60}$ phases. (FR)

18676 STUDY OF ZIRCONIA AT HIGH TEMPERATURES (ABOVE 2000°K). Collongues, R.; Revcolevschi, A.; Foex, M.; Traverse, J. P.; Rouanet, A. (CNRS, Vitry-sur-Seine, France). pp 241-246 of Study of Crystalline Transformations at High Temperatures above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

Three different methods were developed to determine the structure of zirconia at high temperatures: thermal analysis using a solar furnace, high-temperature diffractometry with a metal ribbon furnace and an imaging furnace, room-temperature x-ray diffractometry of quenched products. Results demonstrate that the tetragonal cubic transformation exhibited by the product heated to high temperatures is greatly affected by the nature and pressure of the atmosphere; the possible existence of a perfectly stoichiometric cubic form of zirconia is discussed. (FR)

18677 PHASE TRANSFORMATIONS IN THE U–C AND U–O–C SYSTEMS VIA CONTROLLED OXYGEN AND CARBON POTENTIALS. Tetenbaum, M.; Hunt, P. D. (Argonne National Lab., IL). pp 255-258 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

Phase transformations in the uranium-carbide and uranium-

oxycarbide systems can be effected by controlling the carbon and oxygen potentials in the equilibrating gas. With the binary UC_x system, univariant and bivariant compositions were obtained in the temperature range 2155 to 2455°K by means of a flowing-gas technique with hydrogen–methane mixtures to fix the carbon potential in the gas stream. For the special case of congruent evaporation, the congruent-vaporization composition was established by flowing an inert gas over uranium carbide at high temperature. With the ternary U–C–O system, single and multiphase uranium–oxycarbide compositions were obtained by appropriate choice of temperature, CO partial pressure, and CO/CO_2 ratio in the equilibrating gas stream. Dissolution of oxygen appears to decrease to a significant extent the activity of carbon in uranium carbide. (FR)

18678 TRANSITION TEMPERATURE OF BERYLLIUM OXIDE. Sata, T.; Takahashi, T. (Tokyo Inst. of Tech.). pp 331-334 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

DTA techniques were used to measure the reversible transition temperature of BeO, samples having four different degrees of purity being used in the experiments. A value of 2107 ± 7°C was established. The heat of transition 56 ± 10 cal/g was determined from the DTA peak and comparisons made with the heat of fusion of alumina. The effect of oxide additions (MgO, CaO, ThO_2) on the transition temperature was not convincing within the limits of experimental error. All the compositions in the BeO–ThO_2 system yielded a constant transition temperature. The BeO transition temperature can be used as a standard for DTA at temperatures in excess of 2000°C. (FR)

18679 U–C–O SYSTEM AT 1770°C HIGH-TEMPERATURE X-RAY INVESTIGATIONS UNDER THERMODYNAMIC EQUILIBRIUM CONDITIONS. Pialoux, A.; Dode, M. (Paris Univ., Orsay, France). pp 415-427 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

Sample pellets of known weight and various initial compositions: $UO_2 + nc$ ($O \leq n < 5$) were heated for some time at 1769°C in the presence of CO in a laboratory-constructed x-ray furnace. When equilibrium was reached, the solid phases were identified and their parameters calculated. The overall compositions of the samples were deduced from the quantities of CO released or absorbed, a previous calibration of the furnace having already been made. The $P_{(CO)} = f(O/U)$ and $f(C/U)$ isotherms are in excellent agreement with the diffraction patterns obtained. These patterns reveal the existence of a narrow bivariant domain (graphite, UO_2, CO) and confirm the existence of two monovariant plateaux (graphite, UO_2, UC_2, CO) and (UO_2, UC_2, UC, CO). The parameters of the phases in equilibrium at 1769°C are as follows: UO_2, a = 5580 ± 0.001; αUC_2, a = 3.649 ± 0.003, c = 6.018 ± 0.005; UC, a = 5.090 ± 0.002. Studies of the isotherms indicate that the UO_2 oxygen index must be in the 1.95 region and that of UC_2 comparatively small. Calculations suggest that UC_2 is probably highly substoichiometric. The parameters of the UC_2 phase were determined in vacuo between 1000 and 2000°C. (FR)

18680 CHEMICAL CRYSTALLOGRAPHIC CONSIDERATIONS OF THE MIXED OXIDES $La_{2x}Ln_{2-2x}O_3$ (Ln = Dy, Er, Yb or Sc). Application to Studies of Equilibrium Diagrams of La_2O_3–Ln_2O_3 Systems. Badie, J. M.; Coutures, J.; Rouanet, A.; Foex, M. (CNRS, Montlouis, France). pp 439-446 of Study of Crystalline Transformation at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

Certain aspects of ternary oxides were studied in terms of La–Ln couples, where Ln = Dy, Er, Yb, or Sc. Investigations were made over a wide temperature range up to the melting point. The primary or intermediate solid solutions present the basic lanthanide sesquioxide structures. This property manifests itself as a result of the mutual substitution of the cations present together with the conservation of the anion lattice. The disorder of the crystal lattice configuration is dependent on the concentration and size of the substituted cations and determines the extent of the homogeneity in the different phases (rate of dissolution, thermal stability, changes in lattice constants). The perovskite-structured compounds $LaLnO_3$ (the conditions for whose existence are defined by the Goldschmidt relations) present various allotropic forms. The thermal stability of these compounds was investigated together with their nonstoichiometric tendencies. The following equilibrium diagrams were established: La_2O_3–Dy_2O_3; La_2O_3–Er_2O_3; La_2O_3–Yb_2O_3, and La_2O_3–Sc_2O_3. (FR)

18681 $(U,Gd)O_{2.00}$ PHASE EQUILIBRIA AT HIGH TEMPERATURES. Grossman, L. N.; Packard, D. R.; Hill, H. W. (General Electric Co., Pleasanton, CA). pp 453-458 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The high-temperature, urania portion of the $(U,Gd)O_{2.00}$ equilibrium phase diagram was investigated. Previously published solidus and subsolidus data for this system were found to be at variance with the present study. The solidus descends from 2760°C for $(U_{0.97}Gd_{0.03})O_2$ to 2620°C for $(U_{0.86}Gd_{0.14})O_2$. The subsolidus equilibrium phase is fluorite solid solution for temperatures above 1740°C and for compositions containing up to at least 27% Gd cations. Sintering for 32 h at 1750°C is insufficient to remove inhomogeneities (front blending $UO_2 + Gd_2O_3$) larger than about 50μ in diameter. The lattice parameter for $(U_{1-a}Gd_a)O_{2.00}$ decreases linearly from 5.4709 ± 0.0001 A at a = 0 to 5.4476 ± 0.0005 A at a = 0.1416; the deviation from linearity is less than 0.001A. The ratio O/(U + Gd) is 2.00 ± 0.01 for $a \leq 0.14$ at 1740°C and $\Delta G(O_2) = -166$ kcal/mole. (FR)

18682 INTERPRETATION OF THERMODYNAMIC PROPERTIES OF NONSTOICHIOMETRIC PHASES. Application to the Uranium–Carbon System Between 2000 and 2400°K. Allibert, M.; Mathieu, J. C.; Bonnier, E. (Ecole Nationale Superieure d'Electrochimie et d'Electrometallurgie, Grenoble, France). pp 259-263 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

A statistical interaction model applicable to many different types of solid solutions and especially to nonstoichiometric compounds was established. When the structural study defines the nature of the defects responsible for the nonstoichiometry, this model leads to simple expressions for the thermodynamic functions and the number of defects present. This model was applied to Storms' data for the partial Gibbs free energy of the $UC_{1\pm x}$ phase between 2000 and 2400°K. The simplest form of the model allows interpolations and extrapolations of thermodynamic functions to be made. In this way certain phase boundaries, e.g. the number of defects corresponding to any given concentration, can be calculated. (FR)

18683 EFFECT OF A^{4+}–Ln^{3+} TYPE CATION SUBSTITUTIONS ON POLYMORPHISM OF LANTHANIDE SESQUIOXIDES. Application to Interpretation of Equilibrium Diagrams of ZrO_2–Ln_2O_3 and ThO_2–Ln_2O_3 Systems. Sibieude, F.; Rouanet, A. (CNRS, Montlouis, France). pp 459-468 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

A comparative study was made of the binary systems ZrO_2–Ln_2O_3 and ThO_2–LnO_3. High-temperature x-ray diffraction techniques (powder method) enabled the stability of the various phases encountered and their different behavior as a function of the MO_2 composition to be investigated together with the new structures arising. The effects of Zr^{4+} and Th^{4+} substitution on the different allotropic varieties (C, A, H, B, and X) of the lanthanide sesquioxides were studied. Particular attention was given to the intermediate A-form phases observed in the ThO_2–La_2O_3 system. (FR)

18684 INFLUENCE OF THE HARD-MATERIAL COMPONENTS ON SOME PROPERTIES OF HARD METALS, CONSIDERING ESPECIALLY MODERN DEVELOPMENT OF WORKING MATERIALS. Grewe, H. (Ledermann and Co., Horb, Ger.). Z. Werkstofftech.; 4: No. 4, 209-214(1973). (In German).

Some properties of hard metals and their application are discussed. First of all, the properties of tungsten carbide, titanium carbide, and tantalum carbide in the conventional hard metals are described, also pointing to the possibilities of linear-analytical structure examination in connection with tool-life tests. Also, the field of special working materials with carbide phase used nowadays besides conventional carbide-base hard metals is briefly reported. 5 figures, 3 tables, 16 references. (GE)

18685 SYNTHESIS AND PHYSICOCHEMICAL PROPERTIES OF REFRACTORY COMPOUNDS IN SYSTEMS $Ln_2O_3(LnO)-SiO_2$, $Ln_2O_3-GeO_2$, AND $Ln_2O_3-ZrO_2$. Leonov, A. I.; Bondar, I. A. (Inst. of Silicate Chemistry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 50-53(Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 56-60(Jan 1973).

A comparative classification of rare earth silicates and germanates is given. A series of europium(II) compounds was obtained. The formation and decomposition of solid solutions of zirconium dioxide with rare earth oxides were investigated. 2 tables, 2 figures, 15 references. (auth)

18686 COLORATION OF CRYSTALLINE QUARTZ DURING REACTOR IRRADIATION. Zubov, V. G.; Osipova, L. P. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 14: No. 2, 196-200(1973). (In Russian).

The absorption spectrum (in the region from 350 to 700 μ) of crystalline quartz, irradiated with an integral fast neutron flux from 4×10^{18} to 6×10^{19} n/cm^2, was investigated. The position of the absorption maximum was changed, and the visible coloration of the samples was associated with the varying doses of irradiation. The coloration center model, responsible for the absorption at the maximum of about 450 to 550 μ, is considered. (tr-auth)

18687 INTERACTION OF IONIZING RADIATION WITH RUBY. Ermolaev, E. A.; Shelekhin, Yu. L.; Votinov, M. P. Tr. Leningrad. Politekh. Inst.; No. 325, 78-80(1971). (In Russian).

A rose-colored ruby (0.05% Cr_2O_3) was irradiated with ^{60}Co γ radiation (dose = 10^8 R) and with thermal neutrons (10^{16} to 10^{17} n/cm^2) at room temperature. Monocrystals of corundum and ruby were exposed to 10^4 R of x radiation at the temperature of liquid nitrogen. The irradiated crystals acquired an orange tint, and two bands of additional absorption appeared in the optical spectrum at 370 and 460 nm. The Cr^{3+} content dropped by 11 to 18%, and the nonhomogeneity of the inner crystalline field increased by 30 to 40%. The coloration evoked was associated with a change in the valence state of Cr and the formation of color centers as defects in the matrix. (tr-auth)

18688 APPLICATION OF VACUUM-DEPOSITED THIN FILMS TO ELECTRONICS. Dalmasso, C.; Sella, L. Vuoto Sci. Technol.; 4: No. 4, 175-192(Dec 1971). (In Italian).

The production, by vacuum sputtering, of resistance materials including Ni-Cr alloys, Ta, TaN, and cermets, and of dielectrics including SiO_2, Ta_2O_5, TiO_2, and Al_2O_3 is discussed, and the film properties are noted. The application of these films to passive components (conductors, resistors, and capacitors), superconducting circuits, active components (semiconductors and transistors), and magnetic and optically active devices is described. (22 references) (Metals Abstr.)

18689 MECHANISM OF DIFFUSION ACCELERATION IN THE UO_2-W SYSTEM IN THE PROCESS OF ELECTRON IRRADIATION. Yurgens, A. V.; Abdullin, A. G.; Tsvetaev, A. A. pp 217-220 of Fiziko-Khimicheskie Problemy Kristallizatsii. Vypusk. 2. Alma-Ato, USSR; Kazakhskii Gosudarstvennyi Univ. (1971).

Interpretation of the effects of diffusion acceleration depended on the type of bombarding particles and on the conditions of the experiment. Agreement of theory and experiment was satisfactory. An increase in the diffusion coefficient of U in W with electron irradiation was discussed in terms of the theory of combined mechanism of radiational annealing. (tr-auth)

18690 SUBSOLIDUS STRUCTURE AND FUSIBILITY DIAGRAM OF THE SYSTEM $BaO-ZrO_2-Al_2O_3$. Mel'nik, M. T.; Ved, E. I.; Ilyukha, N. G. (Kharkov Polytechnic Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 2, 302-303(Feb 1973).

Translated from Izv. Nauk SSSR, Neorg. Mater.; 9: No. 2, 332-333(Feb 1973).

An investigation was made of the subsolidus structure of the system $BaO-ZrO_2-Al_2O_3$ by means of x-ray phase and petrographic analysis. The results are tabulated of the products obtained by sintering specimens of the system at 1600°C for 4 hours. Experimental data on refractorinesses of individual mixtures were compared with literature data. (MCW)

18691 MELTING REFRACTORY DIELECTRICS BY DIRECT HIGH FREQUENCY HEATING IN A COLD CONTAINER. Aleksandrov, V. I.; Osiko, V. V.; Tatarintsev, V. M.; Udovenchik, V. T. (Lebedev Inst. of Physics, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 2, 212-214(Feb 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 2, 236-238(Feb 1973).

It is shown that it is possible to melt a large group of oxides and oxide compounds of high purity by direct high-frequency heating in a "cold" container. Melts of oxide materials containing aluminum oxide dissolve oxygen from the atmosphere. During melting, the melts are rapidly mixed, which permits rapid attainment of equilibrium between the gaseous medium and the melt. An advantage of this process is the possibility of fusing substances in oxidizing or neutral conditions without contamination of the material during fusion. The method permits the creation of an open melt surface, which makes it easy to obtain equilibrium between the melt and the gaseous atmosphere, which can be either oxidative, reducing, or neutral. Oxidation-reduction equilibrium between the melt and the atmosphere is achieved (according to the volume of the melt) in 5 to 10 min. The temperature at the melt surface can be regulated over a wide range, from near the melting point to 300 to 500°C above it. (MCW)

18692 DEPENDENCE OF SHRINKAGE OF Y_2O_3 ON HEATING RATE. Kostic, E.; Ristic, M. M. (Boris Indric Vince Inst. of Nuclear Physics, Belgrade). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 2, 225-228(Feb 1973).

Translated from Izv. Akad. Nauk. SSSR, Neorg. Mater.; 9: No. 2, 252-256(Feb 1973).

The compaction process during sintering of green pressings of Y_2O_3 powder was discussed. The heating rate has a marked influence on the shrinkage of Y_2O_3 powder at 1300 to 1700°C. Up to 1400°C much greater shrinkage on rapid heating is obtained whereas at higher temperatures this difference gradually decreases, so that at about 1700°C the opposite effect occurs. It is shown that Geguzin's equation can be used in kinetic analysis of the shrinkage process, and it is confirmed that isothermal sintering of yttrium oxide is controlled by diffusion processes. Differences are observed between the sintering mechanisms for isothermal and nonisothermal heating of the specimens: this must be taken into account in discussing the results of experiments on sintering of oxides. (auth)

18693 ELECTRICAL PROPERTIES IN THE SYSTEM $Sc_2O_3-V_2O_3$. Bazuev, G. V.; Perelyaev, V. A.; Shveikin, G. P. (Inst. of Chemistry, Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 2, 229-231(Feb 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 2, 257-259(Feb 1973).

It has been established that at 290°K the conductivity of cubic solid solutions $(Sc_{1-x}V_x)_2O_3$ increases with the V^{3+} content. In the range 77 to 700°K all the compositions have semiconductive conductivity. The effect of Sc^{3+} cations on electrical transition in V_2O_3 has been examined. With increasing Sc^{3+} content, the conductivity jump markedly decreases, the transition becomes increasingly indistinct, and the transition point is displaced toward lower temperatures. The observed transition from metallic to semiconductive conductivity is apparently due to an increase in the interatomic spacings V-V in the corundum lattice and may be described on the basis of Mott's model. (auth)

18694 USE OF X-RAY ANALYSIS TO INVESTIGATE PHASE RELATIONS IN THE SYSTEMS HfO_2-CaO AND $HfO_2-Y_2O_3$. Gavrish, A. M.; Sukharevskii, B. Ya.; Zoz, E. I.; Solov'eva, A. E. (Ukrainian Scientific-Research Inst. of Refractories, Kharkov). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 2, 232-235(Feb 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 2, 260-264(Feb 1973).

Formation and decomposition of solid solutions in the systems HfO_2-CaO and $HfO_2-Y_2O_3$ were investigated and sectors of the phase diagrams of these systems were constructed. After prolonged isothermal residence at high temperatures (up to 2100°C) in argon, cubic solid solutions in the systems HfO_2-CaO and $HfO_2-Y_2O_3$ retain their structure and do not decompose. The possibility of formation of ternary cubic solid solutions of the fluorite type in the system ZrO_2-HfO_2-CaO was shown. (auth)

18695 ELECTRICAL PROPERTIES OF TITANONIOBATES OF RARE EARTHS OF THE CERIUM SUBGROUP. Krylov, E. I.; Borisov, A. K.; Kazantsev, V. V. (Ural Polytechnical Inst., Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 2, 240-243(Feb 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 2, 269-272(Feb 1973).

The temperature dependence of the electrical conductivity and its character in polycrystalline specimens of Ce, Pr, Nd, Sm, and Eu titanoniobates was investigated. The electrical resistances of the specimens (disks of diameter 10 mm and thickness 1 to 3 mm) were measured by the compensation method, using an E6-3(U-105v) teraohmmeter and a UM-2 bridge. All the measurements were performed in air in the range 20 to 1000°C. The specimen was kept at each temperature for a period sufficient to establish thermal equilibrium. These measurements were performed during heating and cooling. Sigma equations of the log σ vs $10^3/T$ curves were derived and the activation energy of conductivity of these compounds was calculated. Forbidden-zone widths were determined from the fundamental absorption edge. The character of

the conductivity was investigated by measuring the emf by means of the electrochemical cell. The character of the conductivity was deduced by comparing the experimental emf with the value calculated thermodynamically. Cerium, praseodymium, neodymium, samarium, and europium titanoniobates have electronic conductivity and are n-type semiconductors with resistivity $0.5 \cdot 10^{-7}$ to $0.5 \cdot 10^{-12}\ \Omega^{-1} \cdot cm^{-1}$ at 20°C. (MCW)

18696 RELEASE OF TRAPPED CHARGE CARRIERS BY PHONONS GENERATED BY α-PARTICLES. Riehl, N.; Mueller, A.; Wengert, R. (Technische Univ., Munich). Z. Naturforsch., a; 28: No. 6, 1040-1041(1973). (In German).

It was shown in previous papers that trapped charge carriers can be used at low temperatures for detection and free path determination of single phonons. Using this method, it is shown that because of the high phonon density of a phonon pulse generated by one alpha particle, the action of such phonons on trapped charge carriers is mostly a multiphonon action so that the carriers can be released from trap depths which are much greater than the energy of a single phonon. Because of the great free paths of phonons at low temperatures, this action can take place in distances up to 1 mm from the path of the alpha particle itself. (GE)

18697 EFFECTS OF NEUTRON IRRADIATION ON THE STRUCTURE AND PROPERTIES OF ZIRCONIUM CARBIDE. Koval'chenko, M. S.; Rogovoi, Yu. I. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 2, 290-292(Feb 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 2, 321-322(Feb 1973).

An investigation was made of the changes in microstructure, lattice parameter, electrical resistance, and microhardness in zirconium carbide with the composition $ZrC_{0.98}$ under the influence of integral thermal neutron fluxes of $1.0 \cdot 10^{19}$, $3.7 \cdot 10^{19}$, $7.5 \cdot 10^{19}$, and $1.5 \cdot 10^{20}$ neutrons/cm^2 from a VVR-M reactor at 50°C. The radiation dose was determined from the flux of thermal neutrons. The fast-neutron fluxes were about an order of magnitude smaller than those of thermal neutrons. The quality of the microsections did not alter appreciably after irradiation. Any changes in linear dimensions of the specimens after irradiation were less than the error of measurement. Irradiation leads to an increase in lattice parameter and it is inferred that there is a marked rise in the concentration of interstitial atoms in irradiated ZrC. A linear increase in electrical resistance is observed up to radiation doses of $7.5 \cdot 10^{19}$ neutrons/cm^2, evidence that radiation annealing does not occur. The fall in the rate of growth of the electrical resistance and lattice parameter at doses above $7.5 \cdot 10^{19}$ neutrons/cm^2 is accompanied by a marked increase in microhardness and by a blurring and weakening in the (333) line. (MCW)

Metals and Alloys

Refer also to abstracts 18092, 20556, 20597, and 20645.

18698 Zr Hf NEWSLETTER, JUNE 1973. Akron, NY; AMAX Specialty Metals Corp. (1973). 15p.

Research and development in Zr and Hf technology are reviewed. Data and information are included on Hf, Zr metal, Zr-base alloys, Zr as an alloying element, and refractory compounds of Zr and Hf. 280 references are included. (JRD)

18699 METALLOVEDENIE TSVETNYKH METALLOV I SPLAVOV. (Metal Science of Nonferrous Metals and Alloys). Drits, M. E. (ed.). Moscow; Izdatel'stvo Nauka (1972). 200p.

The papers deal with numerous aspects of the metallurgy and metallography of aluminum, magnesium, copper, and titanium alloys. The topics studied include new alloys, phase equilibria, strengthening mechanisms, processing methods, and deformation. Improved production processes and new alloying elements are proposed. (IAA)

For abstracts of individual papers see: 18783–18788.

18700 FUEL-ELEMENT COMPONENTS. Summer, K. C. (British Nuclear Fuels Ltd., Risley, Eng.). Kerntechnik; 15: No. 4, 162-166(1973).

The factors influencing the choice of materials for, and the manufacture of, components for fuel elements are examined. As far as possible the use of standard commercial materials is desirable; specific requirements, however, are taken into account and are used in the development of materials such as magnesium base alloys, nickel base alloys, and zirconium base alloys, which are considered in some detail. Fuel cans, end caps, spacer grids, and braces are the main components, the manufacture of which is discussed. (GE)

18701 POROSHKOVAYA METALLURGIYA. (Powder Metallurgy). Kiparisov, S. S.; Libenson, G. A. Moscow; Izdatel'stvo Metallurgiya (1972). 527p.

Powder metallurgy in the Soviet Union is treated in two chapters on production of powders, three chapters on pressing and sintering, and five chapters on metalloceramic materials and products. (DEB)

18702 TUNGSTEN NEWS, JULY 1973. Tungsten News; 1-17(Jul 1973).

Among the news reported are: the tungsten stockpile, conferences, tool materials, uses of tungsten carbide and alloys, tungsten additions to steels and other alloys, recovery and analysis, and chemical compounds. (323 references) (DLC)

18703 IMPROVEMENTS IN OR RELATING TO HEAT-RECOVERABLE ALLOYS. Brook, G. B.; Iles, R. F. (to Fulmer Research Inst. Ltd.). British Patent 1,315,653. May 1973. Filed date 29 Apr 1970. 4p.

It is known that certain alloys are "heat recoverable", that is to say, when a suitably heat treated article made from the alloy is caused to deform into another shape at an appropriate temperature and the temperature is subsequently raised sufficiently, the article will at least partly recover its original shape. The change of shape on reheating corresponds to a phase change in the alloy from a low-temperature phase to a high-temperature phase. The effect is known to occur with Ni–Ti alloys containing 52 to 56% Ni, and with certain Au–Cd, Cd–Ag–Au, and In–Tl alloys; also with certain U alloys. A method is described for making a "heat recoverable" article comprised of a binary U alloy containing 2 to 7% Mo, 3 to 11% Nb, or 2 to 7% Re, or a Mn–Cu binary alloy containing 5 to 50% Cu, by cooling from a first temperature to a lower temperature, and deforming the alloy at the lower temperature into a second shape, the temperatures being such that on reheating to an appropriate temperature the alloy will at least partly regain its first shape. Examples are given. (UK)

18704 IMPROVEMENTS IN OR RELATING TO HEAT-REMOVABLE ALLOYS. Brook, G. B.; Iles, R. F. (to Fulmer Research Institute Ltd.). British Patent 1,315,652. 2 May 1973. Filed date 1 May 1969. 6p.

It is known that certain alloys are "heat recoverable", that is to say, when a suitably heat treated article made from the alloy is caused to deform into another shape at an appropriate temperature and the temperature is subsequently raised sufficiently, the article will at least partly recover its original shape. This change of shape on reheating corresponds to a phase change in the alloy from a low-temperature phase to a high-temperature phase. The effect is known to occur with Ni–Ti alloys containing 52 to 56% Ni, and with certain Au–Cd, Cd–Ag–Au, and In–Tl alloys. Other alloys possessing this property are U–2 to 7% Mo, U–3 to 11% Nb, U–2 to 7% Re, and Mn–5 to 50% Cu. A method is described for making articles from such alloys, in which a strain is applied to the alloy in its high-temperature phase to produce a stress that induces the desired shape in the low-temperature phase. Examples are given. (UK)

18705 NOVEL PLATINUM–RHODIUM–TUNGSTEN ALLOY. Liu, C. T.; Inouye, H. (to United States Atomic Energy Commission). U. S. Patent 3,737,309. 5 Jun 1973. Filed date 15 Feb 1972. 6p.

An alloy is described which is suitable for use as a radioisotope fuel encapsulation material. The alloy is compatible with the isotope heat source and has excellent oxidation resistance. The alloy composition is 25 to 30 wt % Rh, 6 to 10 wt % W, and balance Pt. Several examples of such alloys and their properties are given. (6 tables). (DLC)

Corrosion and Erosion

Refer also to abstract 20600.

18706 (AEC-tr-7450) EXPERIMENTAL RESULTS OF SOME FRETTING CORROSION TESTS OF METALLIC MATERIALS. Lupoli, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [nd]. Translation of RT/ING-(72)7. 27p. Dep. NTIS $3.50.

A parametric study of fretting corrosion in water was conducted, first on a Cu/steel couple simulating a BWR control rod, and second on Zircaloy-2 on itself and on Inconel. Effects of oscillating frequency, contact pressure, oscillation amplitude, contact materials, passivation, and ambient medium (air or N_2) were studied. (DLC)

18707 UNLUBRICATED SLIDING WEAR OF Ti–6Al–4V. Moore, E. M. Jr. Nashville; Vanderbilt Univ. (1972). 146p. University Microfilms Order No. 73-14,523. Thesis (Ph. D.).

Although titanium and its alloys have high strength-to-weight ratios as well as good elevated temperature performance, corrosion and erosion resistance, and fatigue strength, they are often limited to use as structural components because of their pronounced tendency to gall and seize during sliding. The problem with titanium alloys is their poor lubricity. The surface oxide, rutile, is chemically rather inert, and as a result neither solid nor liquid lubricants bond strongly to the surface. When sliding occurs the lubricant film is squeezed out from between the contacting asperities on the mating surfaces, which then rub together in an essentially unlubricated state. The unlubricated sliding wear of the industrially important titanium alloy Ti-6Al-4V has been investigated for couples in the annealed, hydrided, and nitrided conditions. The effects of load and humidity on wear rates and surface topology have been determined. The beneficial effects on the wear behavior of surface hardening treatments involving interstitial diffusion, often cited in the literature, have been attributed to the reduced ability of the titanium matrix to undergo plastic deformation. All known titanium alloys exhibit essentially the same wear behavior, so the results obtained using the alloy Ti-6Al-4V are considered applicable to titanium and its alloys in general. Ti-6Al-4V wears by a two-stage mechanism. The first stage involves the build up of lumps of material on the surfaces comprised of micron-sized, or smaller, particles machined off the mating surface or picked up from the loose debris. These lumps, called "highlands" because they protrude far above the mean surface level, carry much of the sliding load because they are the largest features on the surface. The second stage in the wear process consists of the fragmentation of the highlands due to repeated stressing at high load levels. The bulk of the loose wear debris found in the sliding system comes from the fragmentation of the built-up highlands. The highland process has been shown to be cyclic, so that the phenomenon is stable. The wear behavior of Ti-6Al-4V is determined by the wear behavior of the highlands. Nitriding and hydriding result in the elimination of the highland phenomenon and a concomitant decrease in the wear rates by two to three orders of magnitude. The interstitial hydrogen and nitrogen distort the titanium matrix so that the lattice ratio is increased towards the ideal close-packed value. It is believed that the slip systems are thereby altered from the Type I prismatic and pyramidal to the basal, resulting in a severely reduced ability of the material to deform plastically. This in turn lowers the adhesive tendency of titanium by reducing the real area of contact between mating asperities. The highland phenomenon requires strong adhesion and disappears in systems that have been hydrided or nitrided. When the diffusion coating is worn away, highlands appear and the wear rates increase to the values exhibited by annealed couples, thus demonstrating that the higher wear rates connected with annealed titanium couples are due to the existence of highlands on the surfaces. A technique is suggested by which adherent, wear resistant coatings may be applied to titanium alloys. It is proposed that the titanium oxide be removed by sputter etching, a thin layer of a wear-resistant material such as chromium, nickel, or molybdenum be sputter deposited on the clean titanium surface, and this coating be built up to the desired thickness by conventional means such as electroplating. (Diss. Abstr. Int., B)

18708 SUPPRESSION OF CORROSION OF IRON IN SODIUM. Isaacs, H. S.; Romano, A. J. (to United States Atomic Energy Commission). U. S. Patent 3,726,642. 10 Apr 1973. Filed date 29 Dec 1971. 4p.

A method of reducing the corrosive effects of molten sodium on the walls of an iron bearing containment structure comprising the addition of nickel or chromium to the sodium in solution near to or at the point of the highest temperature in the sodium system is given. (Official Gazette)

18709 INVESTIGATION OF HIGH-TEMPERATURE LOW-PRESSURE REACTIONS BY MOLECULAR BEAM RELAXATION SPECTROSCOPY. Ullman, A. Z. Stanford, CA; Stanford Univ. (1973). 296p. University Microfilms Order No. 73-14,989.

Thesis (Ph. D.).

Gas-solid reactions which lead to volatile products have been studied by the use of a theoretical description of the interaction in terms of absolute rate theory, and by experimental molecular beam techniques. The theoretical calculation provides a means of predicting or understanding the product distribution. The oxidation of molybdenum foils and the bromination of germanium (100) and (111) were studied by molecular beam relaxation spectroscopy. A simple model of gas-solid reactions was solved by the use of absolute rate theory. The model includes adsorption of the reactant, a reversible surface reaction leading to each product, and a desorption step. This model can be solved for certain pressure-dependent product flux ratios. The absolute rate theory solution reduces to the Quasi-Equilibrium result when the surface reactions are in equilibrium. Corrections are derived for nonequilibrium surface reactions, variable heat of adsorption, adsorption-desorption barriers, and non-unit condensation probabilities. Experimental results for the oxidation of rhenium were analyzed, and showed that the surface reaction is in equilibrium, and that there is a slight energetic and entropic difference between adsorbed O leading to atomic oxygen and rhenium tri-oxide. The oxidation of tungsten and graphite was considered in light of this theory. The oxidation of molybdenum leading to the mono-, di-, and tri-oxides was studied by dc and modulated molecular beam mass spectrometry over the ranges 1100 to 2400°C, 1×10^{-6} to 3×10^{-5} torr, and 5 to 500 Hz. The dc results indicated that the reaction orders were not stoichiometric, and were temperature-dependent. This was considered in terms of a model with two oxygen adsorption sites. The modulated beam work showed that the oxides had the same reaction times within experimental uncertainties, and that the slowest step was the diffusion of oxygen to active sites. These sites appear to be grain boundaries on the basis of an estimate of the characteristic diffusion length from the modulated beam experiments, and from a study of surface morphology changes during oxidation. The bromination of germanium was studied by a modulated beam technique from 500 to 1100°K. Above 800°K the phase shift corresponded to a first order reaction. Below 800°K the phase shift decreased from a value approaching the low-temperature limit for a first order reaction, 90°, towards 0°, and was pressure sensitive. This was interpreted in terms of a coverage-dependent reaction probability. The phase shift was also found to be a function of the direction in which the temperature was changed between measurements, indicating that the surface could exist in this temperature range in one of two stable configurations with different coverage-dependences to the reaction probability. These two configurations appear to be random and segregated (island) adsorption. (Diss. Abstr. Int., B)

18710 STRESS CORROSION CRACKING OF ZIRCALOY-2 IN NEUTRAL AQUEOUS CHLORIDE SOLUTIONS AT 25°C. Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Corrosion; 29: No. 4, 157-166(Apr 1973).

Studies have shown that stress corrosion cracking (SCC) of unnotched Zircaloy-2 specimens can be obtained in neutral aqueous chloride solutions provided the specimen is polarized anodically beyond the film breakdown potential. The value of this breakdown potential as a function of chloride concentration has been established for the batch of material used in this study, and is +100 mV (SCE) in 5% NaCl solution. It is possible to achieve this degree of anodic polarization of preoxidized specimens by galvanic coupling. The cracks are initiated by transgranular crystallographic pits, which initiate at points of oxide breakdown, and propagate by largely transgranular active path dissolution. From experiments in D_2O it was possible to show that no hydrogen uptake occurs during the pitting process, within the limits of detectability. (auth)

18711 COMPATIBILITY STUDY FOR VANADIUM-BASE CLADDING MATERIALS WITH CERAMIC FUELS. Ihara, S.; Tanaka, K.; Tojo, S.; Kojima, M.; Akimoto, Y. (Mitsubishi Metal Corp., Omiya, Japan). J. Nucl. Sci. Technol. (Tokyo); 10: No. 2, 106-110(Feb 1973).

Reactivity and compatibility studies were carried out on some vanadium-base alloys with ceramic fuel materials. The vanadium-base alloys studied were V-20% Ti, V-15% Ti-7.5% Cr, and V-5% Cr. The fuel materials with which these alloys were put in contact were UC, UN, (U, Ce)N and (U,Ce) (C,N). Experiments were carried out at 700 and 900°C for both 500 and 1,000 h. Within the conditions studied, V-5% Cr showed good compatibility with all of these fuel materials. At 700°C, no detectable interaction was observed between any of the alloy/fuel combinations. (auth)

18712 CORROSION OF ZIRCALOY-2 IN HIGH-TEMPERATURE FLOWING WATER AND STEAM. Shimizu, Y.; Ito, G.; Usuki, R. (National Research Inst. for Metals, Tokyo). Nippon Genshiryoku Gakkaishi; 15: No. 4, 248-255(Apr 1973). (In Japanese).

Corrosion experiments on Zircaloy-2 were performed with a corrosion loop and an autoclave containing saturated water, water vapor mixture, saturated steam, and superheated steam in the temperature range of 310 to 320°C. Results are summarized: (1) Adhesion of the cladding increases with the content of dissolved oxygen and the flow rate of water. After decladding, the weight increase by corrosion is not affected by the flow rate of water, nor by any of the conditions of the water. (2) The weight of zirconium transferred into water can be determined by oxygen analysis of the exposed specimen. (3) 80% of the oxygen content introduced by corrosion reaction dissolves into the metallic zirconium, and only 20% of the remainder into the oxide film. (auth)

18713 CORROSION RESISTANCE OF Ni–Cr STAINLESS STEEL IN HIGH-TEMPERATURE FLOWING WATER: CORROSION AND STRESS CORROSION-CRACKING BEHAVIOR IN HIGH-TEMPERATURE WATER. Ito, G.; Shimizu, Y.; Ishihara, T.; Fujii, T. (National Research Inst. for Metals, Tokyo). Paper No. 8. Tokyo; International Nickel Japan Ltd. (1972). vp. (In Japanese).

From international nickel power conference; Kyoto, Japan (28 Nov 1972).

Results of out of pile tests on the corrosion behavior of Cr-Ni stainless steels in pure water at high temperatures are reported: The general corrosion rate of Cr-Ni stainless steels under the testing condition simulating the environment in water cooled power reactor was examined. The effects of dissolved oxygen, flow rate of water, and testing temperature on the corrosion behavior of austenitic stainless steels was studied. The stress corrosion cracking of stainless steel in high temperature water, which is now becoming one of the most important problems in power industry was also studied. The effects of alloying composition, impurities, heat treatment, structure, and welding of steels on their susceptibility to stress corrosion cracking was examined in order to develop the composition and treatment of steel more resistant to stress corrosion. Together with those metallurgical investigations, cracking behavior of piping system by internal pressure was studied. (auth)

18714 GORENIYE POROSHKOOBRASNYKH METALLOV V AKTIVNYKH SREDAKH. (Combustion of Powdered Metals in Active Media). Pokhil, P. F.; Belaev, A. F. Moscow; Izdatel'stvo Nauka (1972). 293p.

Aspects of the ignition and combustion of aluminum, beryllium, magnesium, boron, lithium and others, are examined. Extensive experimental and theoretical materials, produced by Soviet and foreign authors over the past 10 to 15 years are summarized. Modern methods of investigation and the primary regularities of ignition and combustion of metals are also presented, and the influence of metal additives on the physical-energetic parameters of powders and explosives are discussed. The book is designed for scientific workers and engineers working in the area of combustion, as well as teachers at universities, graduate students and undergraduates specializing in this area. 51 Tables; 148 Figures; 356 References. (JPRS)

18715 CARBURIZING OF NIOBIUM AND TUNGSTEN IN GLOW-DISCHARGE PLASMA. Kuznetsov, G. D.; Babad-Zakhryapin, A. A.; Lagutkin, M. I. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 987-988(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 11, 52-53(Nov 1972).

During carburizing of molybdenum in glow-discharge plasma based on methane the metal is either saturated with carbon and the interaction of molybdenum with the atmosphere ceases or the previously formed carbide layer is decarburized down to the metal, depending on the discharge energy parameters. This phenomenon was investigated by carburizing tungsten and niobium in glow-discharge plasma. As is well known, tungsten is similar to molybdenum in these processes, while niobium differs considerably. It was found that the process of diffusion saturation of metals with elements from glow-discharge plasma depends on the temperature of the metal being saturated (or the power of the discharge), the concentration of the saturating element in the medium, the time, and the pressure. (JRD)

18716 INTERACTION OF HAFNIUM WITH OXYGEN. Gordeeva, L. T.; Pakhomova, E. F.; Khrenova, E. P. (Kalinin Polytechnical Inst., USSR). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 985-986(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 11, 50-52(Nov 1972).

The interactions of Hf with O at 500 to 1200°C were studied along with parameters of high-temperature scale formation on iodide Hf and zone-refined Hf. Two stages of oxidation are observed in iodide hafnium: the first is characterized by the appearance of a continuous black oxide film and a reduction of the oxidation rate according to a logarithmic law; the second coincides with the appearance of a loose white scale of HfO_2, the oxidation rate increasing sharply, the variation being linear. Oxidation is selective in the grain boundaries. Microhardness measurements showed diffusion penetration of oxygen below the oxide film with formation of solid solutions of oxygen in hafnium. After 2 and 3 h at 800°C almost the entire depth of the grain is oxidized. Zone-refined hafnium oxidizes with a smaller weight gain due to its chemical purity and structural density and an oxide film is formed only on the surface. The thickness of the film after oxidation for 3 h amounts to 5 μ at 800°C, 20 μ at 1000°C, 30 μ at 1100°C, and 50 to 60 μ at 1200°C. Solid solutions are formed below the oxide film of HfO_2 at oxidation temperatures of 1110 and 1200°C, as is confirmed by the microhardness measurements. At 800 and 1000°C the solid solution zone is very small, evidently due to the protective influence of the oxide film and the low solubility of oxygen in hafnium at these temperatures. The activation energy for zone-refined hafnium is respectively equal to 56.26, 14.33, 10.06, and 7.73 kcal/mole at 800, 1000, 1100, and 1200°C. (JRD)

18717 MATERIAL INVESTIGATION ON PRIMARY CIRCUIT EQUIPMENT AT PRESSURIZED WATER NUCLEAR STATIONS. Adlovits, I.; Gillemot, Ferenc. Energ. Atomtech.; 26: No. 5, 223-229(May 1973). (In Hungarian).

The purpose of material tests on the primary circuit of nuclear power stations is to diminish the danger of damage causing pollution of the environment as well as the possibility of breakdown at the power station. The materials of the reactors and pressure vessels are carefully tested for resistance against breaks and low cycle fatigue and the data are utilized in dimensioning. Acid-resistant vessels and linings are controlled for resistance against intercrystalline and stress corrosion. (auth)

18718 EFFECT OF HARDNESS OF TUNGSTEN CARBIDE–COBALT ALLOYS ON WEAR RESISTANCE WITH FRICTION IN LIQUID NITROGEN. Shnyrev, P. D. Mashinovedenie; No. 1, 95-98(1973). (In Russian).

An experimental investigation of wear resistance of tungsten carbide–cobalt alloys in liquid nitrogen medium was conducted. The cobalt content varied from 4 to 20% with Rockwell-A hardness varying from 89 to 85, respectively. The cobalt serves as a binder for the hard, brittle tungsten carbide crystals. A plate made out of VK6 alloy (6% Co) was rubbing against specimens of various alloys under 65 kg/cm^2 load. The wear of the plate increased and the wear of the specimen decreased with the increase of the specimen's hardness. For a given hardness, the wear is lower with alloys having smaller-size grains. (JPRS)

18719 KINETICS OF THE DISSOLUTION OF OXYGEN IN NIOBIUM AT LOW OXYGEN PRESSURES AND HIGH TEMPERATURES. Hoerz, G.; Lindenmaier, K. (Max Planck Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 64: No. 5, 348-352 (1973). (In German).

The kinetics of the oxygen absorption by niobium in flowing oxygen were investigated at temperatures between 1,380 and 2,000°C and at oxygen pressures between 2×10^{-6} and 5×10^{-5} torr. The reaction rate of the absorption of oxygen by niobium was followed by measuring the electrical resistivity of the specimens continuously at the reaction temperature. The specific electrical resistivity of niobium is increased by 3.6 $\mu\Omega \cdot$ cm at 1100°C and only by 3.0 $\mu\Omega \cdot$ cm at 1600°C after 1 at. % oxygen is dissolved. The oxygen absorption by thin niobium specimens in an oxygen atmosphere in the temperature and pressure range of investigation and at oxygen concentrations up to about 1.5 at. % is described by an equation. The reaction coefficient increases from 0.33 at 1400°C to 0.68 at 2000°C. The rate of oxygen absorption by thin niobium specimens in an oxygen atmosphere is determined by the transport of the oxygen gas to the specimen surface and the chemisorption of oxygen with dissociation. (9 figures, 18 references). (GE)

18720 STUDY OF THE BEHAVIOR OF OXIDE PARTICLES IN A 0.25% Be (BY WEIGHT) COPPER–BERYLLIUM ALLOY BY SMALL-ANGLE X-RAY SCATTERING. Naudon, A.; Allain, J.; Martin, P. (Univ., Poitiers, France). Mem. Sci. Rev. Met.; 70: No. 2, 165-169(Feb 1973). (In French).

Small angle x-ray scattering was used to study the effect of temperature on the formation of oxide particles in a Cu–0.25% Be (by weight) alloy together with the effect of annealing. (FR)

18721 INTERACTION OF TUNGSTEN AND MOLYBDENUM MELTS WITH GASEOUS OXYGEN. Kashin, V. I.; Tsilosani, A. G.; Klibanov, E. L. pp 90-98 of Fiziko-Khimicheskie Osnovy Metallurgicheskikh Protssessov, Moscow; Izdatel'stvo Nauka (1973).

A method is developed for studying the interaction of liquid refractory metals with a gaseous phase under conditions of electric-arc heating. Using an arrangement specially constructed for melting refractory metals in a controlled atmosphere at oxygen pressures ranging from 0.1 to 0.001 atm, a study is made of the kinetics of absorption and desorption of oxygen from liquid molybdenum and tungsten and of the kinetics of the interaction of carbon dissolved in molybdenum with gaseous oxygen. The solubility of oxygen at oxygen pressures ranging from 0.0031 to 0.050 atm is found to amount to 0.48 to 3.6 at.% in molybdenum and to 0.028 to 0.450 at.% in tungsten. The solubility constants of oxygen in the two refractory metals are calculated with allowance for oxygen dissociation. (IAA)

18722 PROTECTION OF REFRACTORY METALS AND GRAPHITE AGAINST OXIDATION AND HIGH-TEMPERATURE

CORROSION UP TO 1500°C BY SINTERED $MoSi_2$ COATINGS. Fitzer, E.; Herbst, H.; Schlichting, J. (Univ., Karlsruhe, Ger.). Werkst. Korros.; 24: No. 4, 274-282(1973). (In German).

$MoSi_2$ coatings applied by plasma spraying or isostatic hot pressing protect Ta and Nb against oxidation by forming a glassy coating of SiO_2. Diffusion of Si to the bulk metal is slow because of the low mobility of Si in the intermediate layers of Me_5Si_3 which contain Nb and Ta; oxidation rate then depends on the slow oxygen permeation through the glass layer. A 200-μm silicide layer on Ta would, accordingly, provide some thousand hours' protection at 1500°C. Silicide coatings on graphite, however, must be protected against carburization by applying a diffusion barrier; intermediate layers of TiC are being investigated for this purpose. The useful life data calculated on the basis of the diffusion data have been registered during oxidation tests, too: silicide-coated Ta and Nb withstood oxidation by air at 1500°C for 1000 h, and at 1200°C for 4000 h; carbon with an intermediate TiC layer resisted oxidation at 1500°C for 400 h. Under temperature cycling conditions, it is indispensable to adjust the coefficient of dilatation of the glassy coating to that of the base material by adding GeO_2. (16 figures, 3 tables, 26 references) (GE)

18723 TECHNIQUE OF THINNING CORROSION FILMS FORMED ON ZIRCONIUM-BASE ALLOYS FOR STUDY BY TRANSMISSION ELECTRON MICROSCOPY. Airey, G. P. (Westinghouse Research Lab., Brussels); Sabol, G. P. Prakt. Metallog.; 10: No. 5, 282-285(1973). (In German and English).

A method was developed, using an ion thinning technique, to produce thin films suitable for examination in the electron microscope from corrosion coupons with oxide-film thicknesses ranging from approximately 1 to 15 μm. Two techniques were used to prepare oxide films suitable for thinning in the Ion Micro Milling Instrument. The corrosion coupons consisted of Zircaloy-4 and Zr–2.5 wt % Nb. (GE)

18724 INVESTIGATION INTO THE HOT-STEAM CORROSION OF WELDED INCOLOY 800 PLATE. Leistikow, S; Scheibe, W. (Kernforschungszentrum, Karlsruhe, Ger.). Werkst. Korros.; 24: No. 4, 226-273(1973). (In German).

In the weld seam of Incoloy, the attack produced by hot steam (620°C, 1000 h) is considerably increased, owing to the coarse grain structure formed during the solidification of the metal, because this transformation reduces the number of active lattice defects and thus inhibits the diffusion of the corrosion-preventing chromium. The favorable effect of cold working on corrosion resistance may, on the other hand, be explained in terms of an increased lattice defect density. The corrosion found during the hot steam experiments, however, need not be deemed dangerous because a strongly adherent scale layer is formed which does not give rise to selective penetration. (GE)

18725 INVESTIGATION OF THE PASSIVITY OF IRON BY NUCLEAR MICROANALYSIS USING STABLE OXYGEN ISOTOPES. Agius, B.; Siejka, J. (Ecole Normale Superieure, Paris). J. Electrochem. Soc.; 120: No. 8, 1019-1025(Aug 1973).

A solution of 0.15N sodium borate and 0.15N boric acid in ^{18}O-enriched water was used to study the passivity of iron by means of nuclear microanalysis. It was established that the surface of the sample maintained under cathodic polarization is free of oxygen-18; while in open circuit, the presence of 5×10^{15} atoms/cm^2 of oxygen-18 was detected on the sample which was previously cathodically reduced. Moreover, in the passivity region, the quantity of oxygen-18 fixed on the metal surface varies from $\sim 5 \times 10^{15}$ to $\sim 20 \times 10^{15}$ atoms/cm^2 as a linear function of potential. The value of the apparent electric field of formation was calculated and compared with the literature data deduced from ellipsometric and coulometric measurements. The cathodic reduction of the films was studied by determining the ^{18}O losses of the passive films as a function of the charge passed in the circuit and of the temperature. The mechanism of the cathodic reduction is discussed on the basis of the experimental data. (6 figures, 27 references). (auth)

18726 HYDROGEN EVOLUTION REACTION ON Ti–6Al–4V IN ACIDIC SOLUTIONS OF NaCl–HCl. Aragon, P. J. (Univ. of Los Andes, Merida, Venezuela). J. Electrochem. Soc.; 120: No. 8, 1010-1013(Aug 1973).

The HER on polycrystalline Ti–6Al–4V in acidic solutions of NaCl–HCl at constant concentration of Cl^- = 0.5M, and pH range from 0.65 to 2.5 was studied. Under the present experimental conditions, the reaction was shown to be first order with a Tafel slope of 0.153V. Exchange current densities were in the order of 10^{-8} A-cm^{-2}. An apparent energy of activation of ΔE = 45.3 kcal-mol^{-1} was found. A sharp decrease in potential was observed after reaching about –1.220V (SCE). It is assumed that this effect is due to concentration polarization. Curves corresponding to cathodic polarizations showed a positive deviation from linearity for pH 0.65 and 1.22, presumably due to a second reduction process corresponding to the reduction of a surface oxide film. (auth)

18727 LECTURES ON ELECTROCHEMICAL CORROSION. Pourbaix, M. New York; Plenum Publishing Corporation (1973). 355p. $28.00.

Translated by J. A. S. Green.

This book offers an introduction to the role of chemical and electrochemical thermodynamics in aqueous solutions. Emphasis is placed on the potential–pH equilibrium diagrams known as "Pourbaix diagrams." Electrochemical kinetics of corrosion are also considered, and methods for protection of metals against corrosion are discussed. Author and subject indexes are included. 96 references. (DLC)

18728 USE OF RUTHERFORD BACKSCATTERING TO STUDY BEHAVIOR OF ION-IMPLANTED ATOMS DURING ANODIC OXIDATION OF ALUMINUM: Ar, Kr, Xe, K, Rb, Cs, Cl, Br, AND I. Brown, F.; Mackintosh, W. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Electrochem. Soc.; 120: No. 8, 1096-1102 (Aug 1973).

It is shown that from the energy spectra of He ions backscattered from aluminum, recorded before and after anodic oxidation, the thickness of the oxide films and the positions of ion-implanted foreign atoms within the films can be determined. Information on the composition and uniformity of the films is also obtained. The scope, limitations, and precision of the method are predictable and are discussed. As model experiments the behavior of ion-implanted noble gases was studied. The results agree with previous work and can be interpreted to show that, as expected, both aluminum and oxygen are mobile during the oxidation. The behavior of ion-implanted alkali metals and halogens was also studied. These species were found to be mobile during oxidation and behaved in a manner consistent with their expected ionic charges. (5 tables, 4 figures, 19 references) (auth)

Preparation and Fabrication

Refer also to abstracts 18103, 20231, and 20326.

18729 (BDX-613-865(Rev.)) ALUMINUM PLATING GRAPHITE FIBERS AND BERYLLIUM WIRE. Clay, F. A. (Bendix Corp., Kansas City, Mo.). Aug 1973. Contract AT(29-1)-613. 19p. Dep. NTIS $3.00.

Metal–matrix composites required continuous lengths of aluminum-coated graphite fibers and aluminum-coated beryllium wire. Although short lengths of graphite fibers were successfully plated with aluminum using a CVD batch process, continuous plating was not accomplished because of insufficient process control. A fixture and process were developed for the continuous electroplating of 0.005-inch diameter (127 μm) beryllium wire. A diethyl ether aluminum plating bath was used. Continuous lengths up to 20,000 feet were plated. A total of 505,000 feet were processed. (10 figures) (auth)

18730 (N-73-18759) DEVELOPMENT OF CHEMICALLY VAPOR DEPOSITED RHENIUM EMITTERS OF (0001) PREFERRED CRYSTAL ORIENTATION. Yang, L.; Hudson, R. G. (Gulf General Atomic Co., San Diego, Calif.). 19 Feb 1973. Contract NAS3-15323. 47p. (NASA-CR-121143; Gulf GA-A-12506). NTIS.

Rhenium thermionic emitters were prepared by the pyrolysis of rhenium chlorides formed by the chlorination of rhenium pellets. The impurity contents, microstructures, degrees of (0001) preferred crystal orientation, and vacuum electron work functions of these emitters were determined as a function of deposition parameters, such as substrate temperature, rhenium pellet temperature and chlorine flow rate. A correlation between vacuum electron work function and degree of (0001) preferred crystal orientation was established. Conditions for depositing porosity-free rhenium emitters of high vacuum electron work functions were defined. Finally, three cylindrical rhenium emitters were prepared under the optimum deposition conditions. (auth)

18731 (SLA-73-619) SPUTTER DEPOSITION AND ION-PLATING TECHNOLOGY. Mattox, D. M. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 51p. Dep. NTIS $4.75.

The basic considerations for constructing a deposition system for ion plating or sputter deposition are reviewed. The fundamentals of gas discharges and sputtering relevant to deposition technology are discussed. Several special deposition configurations are given. Process development and control techniques are outlined. (15 figures, 80 references) (auth)

18732 PURGING PRACTICES FOR NUCLEAR PIPE WELDING. Holby, E. Weld. Eng.; 58: No. 1, 20-23(Jan 1973).

Use of consumable inserts and inert-gas backing is preferred for Tig welding of piping for nuclear applications. Root purging by establishment of area environmental control zones is described. The methods include placing of dams in the pipe or total system purging. Dams may be of various types — soluble dams, inflatable-bladder, collapsible-disk or thermally disposable dams. For controlling the effectiveness of the purge enclosure, the use of purging charts which specify flow rates, flow times and other pertinent data for a variety of enclosed sizes is illustrated. (Metals Abstr.)

18733 SINTERED MAGNESIA FOR FUEL ELEMENT CLADDING TO BE COOLED BY CARBON DIOXIDE. Part IV. Mechanical Properties, Creep, and Rupture. Cech, B. (Ustav Jaderneho Vyzkumu, Rez, Czech.); Saxl, I.; Haslingerova, I.; Milicka, K. Jad. Energ.; 19: No. 6, 196-200(Jul 1973). (In Czech).

Sintered magnesia bars were extruded and annealed for a considerable time so as to effect a certain amount of recrystallization. Their mechanical properties such as deformation behavior at elevated temperatures, ductility, strength under tension, and breaking point were observed. Both the extrusion conditions and recrystallization had a noticeable effect on the mechanical properties. The predominant mechanism of deformation was a nonbasal slippage, and its contribution to the total deformation increased during the course of recrystallization. (tr-auth)

18734 EFFECT OF D AND r PARAMETERS ON WELD STRENGTH IN THE BIMETAL NIOBIUM AND STAINLESS STEEL IX18H9T. Bairamashvili, I. A.; Gogichev, I. I.; Tavadze, F. N.; Tarasenko, N. N.; Eristavi, A. M. (Inst. of Mining Mechanics,, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 69: No. 3, 637-640(Mar 1973). (In Russian).

The results of studies on explosive welding of niobium to stainless steel IX18H9T are presented. It is shown that the joint strength is a function of the charge weight to ejected blank weight ratio (r) as well as of the detonation rate (D) of the explosive. Tests proved that there exists a range of r and D values that ensure high-grade welds. (auth)

18735 IMPROVEMENTS IN OR RELATING TO THE REDUCTION OF OXIDES OF REFRACTORY METALS. Jenkins, T. R. (to United Kingdom Atomic Energy Authority). British Patent 1,313,845. 18 Apr 1973. Filed date 23 Apr 1969. 7p.

A method is described for producing W or Mo metal or carbide from their oxides. A bed of the hot oxide is contacted with a stream of CO and the mixed CO and CO_2 off-gases are circulated over a reducing agent, such as a bed of hot C, to reduce the CO_2 to CO for return to the bed. The bed may be maintained at a suitable temperature and the CO_2 concentration at a suitable level so as to produce carbides of the metals, or the conditions may be such as to produce the metals. A description is given of suitable apparatus. No H_2 is present in the process, so that its associated hazards are avoided; there is also no production of H_2O, which causes undesirable grain growth. Furthermore, since the C for the production of carbide is in the gas phase, better control of the stoichiometry of the product is possible, and the process may be used for treating C-deficient carbide made by other routes. (UK)

18736 NEW FABRICATION PROCEDURE OF PHASE-ADJUSTED HIGH-PERFORMANCE FUELS FOR FAST BREEDER REACTORS. Wedemeyer, H. (Kernforschungszentrum, Karlsruhe, Ger.). Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). vp. (In German).

From reactor meeting; Karlsruhe, Germany (10 Apr 1973).

The thermal decomposition of uranium oxalates, followed by a carbothermal reduction of the intermediate product UO_2 in dynamic vacuum at temperatures between 1250 and 1300°C, or a reaction with nitrogen above 1500°C, respectively, leads to single-phase products, as shown by x-ray and metallographic analyses. (GE)

18737 DETERMINATION OF FATIGUE OF WELDED JOINTS WITH ARTIFICIAL FLAWS BY RADIOGRAPHIC EXAMINATION. Ferusic, S. (Istrazivacki Razvojni Centar za Termotehniku i Nuklearne Sirovine, Sarajevo, Yugoslavia). Materialpruefung; 15: No. 5, 157-160(1973). (In German).

125 specimens of rounds for reinforced concrete (16-mm diameter) were investigated which included a welded butt joint with systematic defects. These symmetric wedge-shaped defects had a size of 10 to 40% of the diameter. They were tested by symmetric alternating loads of 175 Hz. All specimens were examined by radiography, and only those were selected that showed a regular geometrical defect. Results were evaluated statistically (relationship between stress, number of cycles, and percentage of flaw size of the weld). By this method the stress amplitude can be determined with a satisfactory degree of accuracy as a function of flaw size — evaluated by radiographs — and number of cycles. An equation was derived that gives the relation between the magnitudes mentioned. (GE)

18738 EFFECT OF COMPOSITION OF THE GAS ATMOSPHERE ON GROWTH AND PROPERTIES OF WHISKERS. Taskaev, I. P. Fiz.-Khim. Mekh. Mater.; 8: No. 6, 105-106(1972). (In Russian).

The growth of W, Mo, and Nb whiskers from various types of raw material in a stream of H or inert gas was studied. The growth of the whiskers involves the development of a certain vortex system in the gas atmosphere, and this system acts as a kind of "memory" for the continued growth of the crystals. If the state of the gas atmosphere in the growth zone is known, the exact growth parameters of the whiskers may be predicted. (Metals Abstr.)

18739 PRODUCTION OF NIOBIUM–STAINLESS STEEL BIMETAL BY EXPLOSION WELDING. Bairamashvili, I. A.; Gogichev, I. I.; Tavadze, F. N.; Tarasenko, N. N.; Eristavi, A. M. Soobshch. Akad. Nauk Gruz. SSR; 69: 637-640(Mar 1973). (In Russian).

Tests were carried out to determine the quality of welds vs detonation rates and charge weight in the production of pipes with bimetal walls by explosion welding of thinner niobium pipes into thicker stainless steel pipes. It was found that the detonation rate could be varied inversely with the charge weight, but should be at least 2.5 km/sec, to achieve the required quality of niobium claddings. (IAA)

18740 PREPARATION AND PROPERTIES OF BETA-TANTALUM AND TANTALUM OXIDE FILMS. Piano, M.; Sella, L. Vuoto Sci. Technol.; 5: No. 2, 73-80(1972). (In Italian).

Surface preparation and techniques for the production of β-Ta and Ta_2O_5 films 250-Å to 1-μm thick are described, together with methods of measuring their resistivity, temperature coefficient of resistance, and film thickness. The application of x-ray diffraction and physical measurements to determine structure, degree of polycrystallinity, and phase transformation temperature is considered, together with the anodic oxidation of Ta to Ta_2O_5 in dilute citric acid. (Metals Abstr.)

18741 PROCESSES OF MOLYBDENUM REDUCTION FROM CALCIUM–MOLYBDENUM–TUNGSTEN–OXYGEN SOLID SOLUTIONS. Dobrovinskii, R. Yu. Sb. Tr. Chelyabinsk. Elektromet. Komb.; No. 3, 114-122(1972). (In Russian).

The preparation of Mo by the H reduction of Ca–Mo–W–O solid solutions was studied. In equilibrium conditions, the H reduction of $CaMo_xW_{1-x}O$ takes place in a stepwise manner with the formation of a series of intermediate phases which may be of fixed or of variable composition. (Metals Abstr.)

18742 ELECTROCHEMICAL MACHINING OF HIGH-TEMPERATURE ALLOYS IN $NaClO_3$ SOLUTIONS. Hoare, J. P.; Chartrand, A. J.; LaBoda, M. A. (General Motors Corp., Warren, MI). J. Electrochem. Soc.; 120: No. 8, 1071-1077(Aug 1973).

Polarization studies were made on seven high-temperature alloys and their machining behavior in a $NaClO_3$ electrolyte: H13 tool steel, Incoloy 901 Ni–Fe alloy, Inconel 713C Ni-base alloy, GMR 235 Ni-based alloy, A286 Ni–Cr stainless steel, HS31 Co-based alloy, and 410 Cr stainless steel. The effects of the composition on the anodic films formed on the alloys were studied. Results show that alloys high in Fe can be machined in $NaClO_3$, but the machining rate may be low if the Cr content is high. Low-Fe alloys result in high metal removal rates if the Ni content is high, but the surface finish is poorer. 9 figures. (DLC)

Properties, Structure, and Phase Studies

Refer also to abstracts 18034, 18035, 18046, 18157, 18158, 18626, 18654, 18655, 18688, 19763, 19764, 19914, 20295, 20300, 20316, 20613, 20617, 20623–20625, 20628, 20629, 20633, 20634, 20636, and 20657.

18743 (AEC-tr-7452) RESISTOMETRIC STUDY OF HYDRIDE PRECIPITATION IN ZIRCALOY-2. Sasaki, Y.; Kimura, H. Translated from Suiyokaishi; 16: 462-465(Oct 1968). 9p. Dep. NTIS $3.00.

The kinetics of the hydride precipitation in Zircaloy-2 was investigated by the resistometric method during aging. Two stages were found in the process of the hydride precipitation. In the first stage the time exponent of 1 was obtained, and it was considered that the precipitates grew in the form of plates whose dimensions were small in comparison with their separations. The second stage, having the time exponent of $\frac{1}{2}$, was interpreted on the basis

of thickening of plates of hydride grown in the first stage. The activation energy determined from the isothermal data was about 8,000 cal/mol in both stages, and this value was in good agreement with that for the diffusion of hydrogen in α-zirconium. (auth)

18744 (AECL-4431) ELECTROCHEMICAL PROPERTIES AND OXIDATION OF SOME ZIRCONIUM ALLOYS IN MOLTEN SALT AT 300°C TO 500°C. Hubner, W.; Cox, B. (Atomic Energy of Canada Ltd.; Chalk River (Ontario). Chalk River Nuclear Labs.). May 1973. 53p. Dep. NTIS (U. S. Sales Only) $4.75. AECL $1.50.

The oxidation rate and current–voltage characteristics of a number of zirconium alloys were determined in a molten-salt environment at 300 to 500°C. The electrochemical measurements are found to be of only limited use for determining the mechanism of the different partial processes contributing to the overall oxidation process, mainly because of hysteresis effects and insufficiently accurate current measurements around the oxidation potential. However, such measurements do seem to offer possibilities for qualitative evaluation of the separate contributions from the partial processes involved in the oxidation reaction. For the ionic transport process the current–voltage relationship and its temperature dependence point to a Tafel-type diffusion process, having an apparent activation energy closely similar to those given in the literature for linear diffusion of oxygen in zirconia. For the electronic, cathodic current no general agreement was found with the several theoretical equations tested. For lower temperatures a strong temperature dependence was found, whereas above 400 to 500°C the electronic current was nearly independent of temperature. Polarization measurements on different binary alloys confirm previous suggestions that the electronic transport process on the Zircaloys is closely related to the presence of Zr–Fe intermetallic particles. (auth)

18745 (AECL-4448) ACCELERATED OXIDATION OF ZIRCALOY-2 IN SUPERCRITICAL STEAM. Cox, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1973. 32p. Dep. NTIS (U. S. Sales Only) $3.75. AECL $1.00.

Although a few earlier examples of excessive oxidation of Zircaloy-2 in high-temperature (>450°C) steam at high pressures (≥1500 psi) have been reported, evidence suggested that at higher steam pressures the effects could be more serious. In this study, it was found that the oxidation rate of Zircaloy-2 rises rapidly as the steam pressure increases into the supercritical region. The large pressure dependence of the oxidation rate is a function of heat treatment, which apparently displaces the oxidation rate versus pressure curve along the pressure axis. Thus, the previous instances of catastrophic oxidation of Zircaloy-2 at high temperatures represent the appearance of highly pressure-dependent oxidation following heat treatments, which shifts the curve into the range of normally employed test pressures (≤1500 psig). The onset of this phenomenon appears to be related to changes in the growth morphology of the oxide. (2 tables, 20 figures, 23 references) (auth)

18746 (AECL–4454) COLOUR CENTRES AND POINT DEFECTS IN IRRADIATED CALCIUM FLUORIDE. Childs, B. G.; Harvey, P. J.; Ritchie, H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1973. 21p. Dep. NTIS (U. S. Sales Only) $3.25. AECL $0.50.

The optical absorbance of single crystals of pure CaF_2 and CaF_2 doped with NaF and YF_3 was measured before and after ^{60}Co gamma irradiation and 18-MeV proton irradiation at 20°C and –196°C. Selected specimens were subsequently annealed at various temperatures up to 300°C. The pure crystals were unaffected by irradiation; however, the Na-doped crystals developed prominent bands at 429, 386, and 316 nm after –196°C irradiation and at 609, 495, 386, and 333 nm after 20°C irradiation. On annealing, the –196°C spectrum was first converted into that for 20°C irradiation. New bands then appeared at 530 and 561 nm as a final stage in the decay of the spectrum. For the Y-doped crystals the main bands were at 586, 512, 333, 313, and 269 nm for –196°C irradiation and at 512, 392, 358, 313, and 245 nm for 20°C irradiation. No new bands were detected on heating above 20°C. Numerous lesser bands have been identified for both specimen types. Certain of the major bands have been tentatively attributed to particular defect centers. (auth)

18747 (CALT-767-P-3-34) INTRODUCTION OF DISLOCATIONS AND SLIP BANDS IN MOLYBDENUM SINGLE CRYSTALS. Lau, S. S.; Vreeland, T. Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). 1972. Contract AT(04-3)-767. 12p. Dep. NTIS $3.00.

The characteristics of selectively introduced slip bands and individual dislocations were investigated. It was found that slip bands produced by indenting the (112) surface had three types of Burgers' vectors concentrated at the two edges of the slip band while the middle of the slip band consisted of primarily the $\pm\frac{1}{2}[11\bar{1}]$ Burger's vector. Scratching the specimen with a needle almost parallel to the $[11\bar{1}]$ surface in the $[11\bar{1}]$ direction produced individual screw dislocations near the scratch mark. Similar scratches normal to the $[11\bar{1}]$ direction produced fine slip bands with a $\pm\frac{1}{2}[11\bar{1}]$ Burger's vector. (auth)

18748 (CONF-730916–1) LOW-CYCLE FATIGUE RESULTS FOR SPOT-WELDED AISI 316 STAINLESS STEEL STRIP AT ELEVATED TEMPERATURES. Flagella, P. N.; Hundal, R. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). 1972. Contract AT(11-1)-3045. 30p. Dep. NTIS $3.50.

From international conference on creep and fatigue in elevated temperature applications; Philadelphia, Pennsylvania, USA (23 Sep 1973).

Spot-welded samples of AISI 316 stainless steel were tested in air at room temperature, 1000, 1150, and 1300°F. Tensile testing was conducted in a Baldwin tensile machine and load-cycle fatigue testing was conducted in a MTS fatigue machine. The creep-rupture testing was conducted at 1150°F in air. Fatigue tests at different cycle frequencies as well as hold-time in tension only were conducted at 1150°F in the MTS fatigue machine and the set up was identical to that used for the constant cycle fatigue testing. Limited relaxation testing was also conducted in the MTS fatigue machine at 1150°F. Correlations of the experimental results for the spot-welded strip are discussed. The fact that the tests involving hold-time in tension correlates with the creep rupture life (one cycle) suggests a possible creep-fatigue interaction. (MCW)

18749 (CONF-730920-1) ASSESSMENT OF THE ACCURACY OF THE HIGH-TEMPERATURE HEAT CAPACITY OF SOLID METALS. Brooks, C. R.; Stansbury, E. E. (Tennessee Univ., Knoxville. Dept. of Chemical and Metallurgical Engineering). 1973. Contract AT(40-1)-3291. 10p. Dep. NTIS $3.00.

From symposium on physico-chemical techniques at high temperatures; Baden, Austria (3 Sep 1973).

Comparison of the values of the reported high-temperature heat capacity of solid metals frequently shows wide variance, usually increasing with increasing temperature. Unfortunately, measurements on specimens made from the same stock material frequently show deviations well outside the uncertainty claimed by the investigators. Typical data on aluminum oxide, Al, Au, Fe, Pt, and Ta are presented to illustrate the significance of the problem. It is clear that the origin of most of the differences lies in unrecognized errors in the experimental techniques. Possible sources of errors and the practicality of establishing a metal as a heat capacity standard are discussed. (45 references) (auth)

18750 (IS-T–583) HIGH-TEMPERATURE HEAT CONTENT OF SELECTED RARE EARTH METALS BY LEVITATION CALORIMETRY. Stretz, L. A. (Ames Lab., Iowa). May 1973. Contract W-7405-eng-82. 157p. Dep. NTIS $10.00.

Thesis.

A levitation melting apparatus was coupled with a conventional calorimeter. Heat contents measured with the system were corrected for convection and radiation heat losses during the fall of the sample from the levitation chamber into the calorimeter. The system was used to measure the heat contents of yttrium, lanthanum, praseodymium, and neodymium at temperatures above their melting points. The measurements extended previous limits up to 2360°K for yttrium, 2419°K for lanthanum, 2289°K for praseodymium, and 2246°K for neodymium. The heat content was a linear function of temperature (constant heat capacity) for all the metals studied. The data were fitted by the following equations: (1) for yttrium, $1799 < T < 2360$°K: $H_T - H_{298.15} = [9.49 \pm 0.13](T - 1799) + [15314 \pm 39]$ cal/mole; (2) for lanthanum, $1250 < T < 2419$°K: $H_T - H_{298.15} = [7.84 \pm 0.04](T - 1193) + [8800 \pm 31]$ cal/mole; [3] For praseodymium, $1512 < T < 2289$°K: $H_T - H_{298.15} = [9.93 \pm 0.07](T - 1208) + [9970 \pm 47]$ cal/mole; and (4) For neodymium, $1497 < T < 2246$°K: $H_T - H_{298.15} = [10.52 \pm 0.09](T - 1297) + [11240 \pm 60]$ cal/mole. (DLC)

18751 (IS-T-591) LOW-TEMPERATURE HEAT CAPACITY OF YPb_3, $LaPb_3$, La_5Pb_3, AND La_5Pb_3C. Demel, J. T. (Ames Lab., Iowa). May 1973. Contract W-7405-eng-82. 63p. Dep. NTIS $5.25.

Thesis.

The heat capacities of one sample of YPb_3, $LaPb_3$, La_5Pb_3C, and two samples of La_5Pb_3 were measured from 2.5 to 20°K. The electronic specific heat constant, γ, of the samples had values ranging from 0.81 to 3.25 mJ/g at. K^2. The Debye characteristic temperatures Θ_D ranged from 121°K to 181°K. Both $LaPb_3$ and YPb_3 were superconducting, but the other two compounds were not. All the lanthanum compounds exhibited a departure from the Debye model at temperatures less than $\Theta_D/10$. The heat capacity of YPb_3 above the superconducting transition fit the Debye model within ±2°K over

the temperature range investigated ($\Theta_D/25$ to $\Theta_D/6$). (12 figures, 8 tables, 44 references) (auth)

18752 (KFK-1792) PRESENTATION OF MATERIAL PROPERTY DATA OF THE SYSTEM MAPLIB IN TABULAR AND GRAPHICAL FORM. Schuster, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). May 1973. 47p. (In German). Dep. NTIS (U. S. Sales Only) $4.50.

MAPLIB (Material Properties Program Library) is a program system capable of furnishing values of material properties. For this purpose it contains FORTRAN IV functions with certain name conventions. This report describes an extension of the system with routines suited for producing tabular and graphical output of MAPLIB data. These new routines permit communication between programs and users in an easily readable form. Exemplary print and plot outputs make this report a reference book for all MAPLIB-integrated properties and materials. (19 figures, 15 tables) (auth)

18753 (N-72-30465) METALLOGRAPHIC EVALUATION OF SOME COATED NIOBIUM ALLOYS. Griffiths, V. (Montana Coll. of Mineral Science and Technology, Butte (USA)). Jan 1972. 28p. (NASA-CR-127917). NTIS.

The results of a metallographic study of two coated niobium shuttle candidate materials are presented. Optical and scanning electron microscopy examinations were conducted on coating R512E and VH109. (STAR)

18754 (N-73-17625) DEVELOPMENT OF ADVANCED HIGH STRENGH TANTALUM-BASE ALLOYS. Phase 3: Influence of Metallurgical Condition on the Mechanical Properties of ASTAR-811C Sheet. Final Report, October 1967-July 1970. Ammon, R. L.; Buckman, R. W. Jr.; Harrod, D. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec 1972. Contract NAS3-10939. 88p. (NASA-CR-121096; WANL-M-FR-72-9). NTIS.

Metallurgical condition was shown to have a significant effect on the creep properties of ASTAR-811C (Ta-8W-1Re-0.7 Hf-0.025C) sheet. Cold-worked material exhibited creep rates 30 times higher than solution-annealed material and 10 times greater than for recrystallized material. Both grain size and the carbide morphology changes as the final annealing temperature was raised from 3000°F to 3600°F. However, the lowest creep rates were achieved for material which retained the high-temperature form of the Ta_2C precipitate. Samples with GTA weldments had essentially identical properties as recrystallized base metal. Cooling rates from 3600°F of 5, 50, and 800°F deg/min had little effect on the 2000 and 2400°F creep behavior of ASTAR-811C. (auth)

18755 (NP-19825) ATOMIC ENERGY REVIEW. Special Issue No. 3. Tantalum: Physico-Chemical Properties of Its Compounds and Alloys. Kubaschewski, O. (ed.) (International Atomic Energy Agency, Vienna (Austria)). 1972. 134p. IAEA $5.00.

Critical evaluation and documentation are given of the following Ta data: thermodynamic properties, densities, crystallographic structures, equilibrium phase diagrams, and diffusion rates in the condensed states. Extensive tables and bibliographies are listed. (DLC)

18756 (SLA-73-5154) MECHANICAL PROPERTIES OF A POTENTIAL PULSED REACTOR FUEL, U-6 WT % Mo. Horak, J. A.; Yao, E.; Rorke, G. L.; Sasmor, D. J.; Gonzalez, F. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 36p. (CONF-730212-5). Dep. NTIS $4.00.

From fast pulsed reactor symposium; Alamogordo, New Mexico, USA (20 Feb 1973).

A program to determine the thermomechanical properties of uranium-base alloys for use as pulsed reactor fuels has been developed. Emphasis to date has been on U-Mo alloys with Mo contents between 6 and 10 wt % in which the γ phase can be retained to room temperature and below. The current work is on the temperature dependence of the mechanical properties of U-6 wt % Mo from 77 to 800°K. The mechanical properties exhibit a large temperature dependence below 300°K and a small temperature dependence above 300°K as observed for other bcc alloys. Fractography studies revealed only ductile-type fracture above 150°K. The degree of plastic deformation prior to fracture and the shear dimple size increased with increasing temperature. The percent elongation and toughness exhibit a decrease just above 400°K, which is the temperature region where the strength increase due to the apparent strain aging of impurity interstitials is a maximum for the alloy. (auth)

18757 (UCID-16286) MODEL RELATING STRESS, STRAIN, STRAIN RATE, AND TEMPERATURE WITH AN EXPERIMENTAL DATA FIT FOR HIGH-PURITY TANTALUM. Lord, D. E. (California Univ., Livermore. Lawrence Livermore Lab.). 18 Jun 1973. Contract W-7405-eng-48. 19p. Dep. NTIS $3.00.

Using the model developed as a result of a strain energy to failure investigation and experimental results from three separate sources for high-purity tantalum, a behavior model fit was accomplished. Tantalum has strengthening "peaks" that are attributed to interstitial oxygen, nitrogen and hydrogen. These cause deviation from the "normal" straight line between θ and temperature in the model. However, behavior is consistent. Increasing strain rate above 10^{-2}/sec produces a sudden anomalous shift toward ductile behavior. Though the shift is sudden, the effect holds throughout the higher strain rates. Tentative stress-temperature relationships have been established by the model for the temperature range from the cryogenic to 2000°K. These, however, only apply for strain rates $<10^{-2}$/sec. The model also seems to be valid for the higher strain rates, but needs verification to extend the ranges beyond room temperature. Not enough data were available to establish the strain variation with temperature, but a very adequate room-temperature strain model was established. This strain model was not affected by the anomalous stress behavior with strain rate, indicating that no structural (phase) change is associated with the stress behavior. (6 figures) (auth)

18758 (UCLA-34-P-177-14) DIFFRACTION CONTRAST EFFECTS AT EXTRINSIC GRAIN-BOUNDARY DISLOCATIONS. McDonald, R. C.; Ardell, A. J. (California Univ., Los Angeles. Dept. of Materials). Feb 1973. Contract AT(04-3)-34. 26p. Dep. NTIS $3.50.

Extrinsic grain-boundary dislocations (GBDs) in Types 304 and 316 austenitic stainless steels, introduced by plastic deformation, were studied by transmission electron microscopy. The disappearance of contrast under certain diffracting conditions was investigated, from which it was concluded that the displacement vector of the GBD is not necessarily unique. Instead, two vectors are required to characterize the displacements in the crystals on either side of the grain boundary. A series of systematic contrast experiments were also performed to determine the conditions for reversal of GBD contrast. It was established that the image of the GBD reverses from black to white, and vice versa, whenever the grain boundary in which it lies is the lower surface of the strongly diffracting grain. If the grain boundary is the upper surface of the strongly diffracting grain, contrast reversal does not occur. This rule applies when one of the two grains on either side of an inclined grain boundary is oriented for two-beam diffracting conditions. (6 figures, 20 references) (auth)

18759 RELATIVISTIC ENERGY BAND STRUCTURE AND PROPERTIES OF γ-URANIUM. Koelling, D. D. (Magnetic Theory Group, Physics Department, Northwestern University, Evanston, Illinois 60201); Freeman, A. J. Phys. Rev. B 7: No. 10, 4454-4463 (15 May 1973).

The electronic band structure of the high-temperature phase of uranium has been determined by means of the symmetized relativistic augmented-plane-wave method. Six different crystal potentials (three atomic starting configurations, $5f^47s^2$, $5f^36d^17s^2$, and $5f^26d^27s^2$, each taken together with $\alpha = 2/3$ and $\alpha = 1$ approximations for exchange) were employed in the warped-muffin-tin approximation. The relativistic effects are found to be very important and result in 5f bands which overlap and hybridize strongly with the very broad "7s-p" and broad 6d bands (which in the absence of the 5f states are found to be those typical of a high-atomic-number transition metal). The nonrelativistic energy bands are found to be incorrect in many ways. A calculated density of states shows considerable structure reflecting the s-d-f hybridization and a relatively high density of states (1.45 states per atom eV) at the Fermi energy. The Fermi surface is found to be complicated and to consist of two hole and one electron surfaces. (auth)

18760 ABSORPTIVITY OF SINGLE-CRYSTAL YTTRIUM AT 4.2 K. Weaver, J. H.; Lynch, D. W. (Ames Laboratory-USAEC and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. B 7: No. 10, 4737-4739 (15 May 1973).

Measurements of the absorptivity of single crystals of Y were made between 0.15 and 4.4 eV at 4.2 K. Polarized radiation was used with the electric vector parallel or perpendicular to the $\hat{c}$ axis of the crystal. The observed structures in the absorptivity were interpreted on the basis of band calculations for Sc, Re, and Gd and qualitative agreement was found between the band structures and the observed spectra. (auth)

18761 DENSITY OF ELECTRONIC STATES IN LIQUID BERYLLIUM. Pant, M. M. (Department of Physics, Indian Institute of Technology, Kanpur-16, India); Das, M. P.; Joshi, S. K. Phys. Rev. B 7: No. 10, 4741-4743 (15 May 1973).

The density of electronic states in liquid beryllium is calculated for both a random and a correlated distribution of atoms using the approach of independent pseudoatoms due to Rousseau et al. (auth)

18762 CONDUCTION-ELECTRON CONTRIBUTION TO ELECTRIC FIELD GRADIENTS IN RARE-EARTH METALS. Devine, R. A. B.; Dixon, J. M. (Ecole de Physique and Ecole de Chimie-Physique, University of Geneva, Geneva, Switzerland). Phys. Rev. B 7: No. 11, 4902-4907 (1 June 1973).

The conduction-electron contribution to the electric field gradients in the heavy rare-earth metals has been calculated using a modified orthagonalized-plane-wave approach. Experimental results can be easily explained within the confines of the model and the amount of 5d character mixed into the conduction-electron wave function (characterized by a parameter ϵ_d) agrees well in both magnitude and sign with previous independent methods of determination. An attempt is made to correlate the magnitude of the 5d admixture with the d density of states in the conduction band. (auth)

18763 NUCLEAR MAGNETIC RESONANCE IN $LaAl_2$. Silbernagel, B. G. (Department of Physics, University of California, Santa Barbara, California 93106); Wernick, J. H. Phys. Rev. B 7: No. 11, 4787-4792 (1 June 1973).

The Knight shifts for the La^{139} and Al^{27} nuclei in $LaAl_2$ have been measured at temperatures from 90 to 300 K. A small systematic variation of the Knight shift is observed in each case and correlated with measurements of the magnetic susceptibility. Comparison with spin-lattice relaxation measurements suggests that hyperfine interactions with the s electrons dominate the spin-lattice relaxation process and account for a significant fraction of the observed Knight shifts. The relatively weak temperature dependence may suggest appreciable f character of the Fermi-surface electrons. (auth)

18764 OPTICAL PROPERTIES OF NIOBIUM FROM 0.1 TO 36.4 EV. Weaver, J. H.; Lynch, D. W.; Olson, C. G. (Ames Laboratory, U. S. Atomic Energy Commission and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. B 7: No. 10, 4311-4318 (15 May 1973).

The absorptivity or reflectivity of single crystals of Nb has been measured from 0.1 to 36.4 eV. The data were Kramers-Kronig analyzed and the optical constants obtained. The absence of low-energy interband transitions has been noted, while interband effects have been observed beginning at about 1.4 eV and extending to about 19 eV. Comparisons with existing experimental data are made. Identification of some interband effects has been tentatively made from the band structure calculated by Mattheiss. The loss function has been obtained and strong resonances have been noted at 9.9 and 20.8 eV. From our spectra of the complex dielectric constant, we can identify both of these as being plasmon excitations. The onset of core transitions at about 28 eV has been observed. (auth)

18765 NITRIDE PRECIPITATES IN A $Nb_{80}Ta_{20}$ ALLOY. Schober, T.; Antesberger, G. (KFA Juelich, Juelich, Ger.). Scr. Met.; 7: No. 7, 731-734(Jul 1973).

Results of an investigation by electron microscopy of the nitride precipitation and the structure of the precipitates in $Nb_{80}Ta_{20}$ alloy are presented. Electron microscopic examination of the nitride precipitates revealed that the microstructure conforms to a model represented by the formula Nb_2N rather than NbN. The latter would be superconducting, whereas the former would not. (JRD)

18766 MOBILITY OF HYDROGEN AND DEUTERIUM IN TANTALUM BETWEEN 4.2 AND 60°K. Hanada, R. (Tohoku Univ., Sendai). Scr. Met.; 7: No. 7, 681-686(Jul 1973).

Results of resistivity measurements of H- and D-doped Ta specimens are presented. The mobility of H or D between 4.2 and 60°K was determined by measurement of resistivity recovery due to precipitation of H or D during Ta quenching. Data on resistivity recovery and normalized derivative curves for H- and D-doped specimens are presented and discussed. (JRD)

18767 MECHANICAL PROPERTIES OF TWO URANIUM ALLOYS AND THEIR ROLE IN THE OXIDATION OF THE ALLOYS. Cathcart, J. V.; Liu, C. T. (Oak Ridge National Lab., TN). Oxidation Metals; 6: No. 2, 123-143(1973).

The creep and tensile properties of two uranium alloys (U-21 at. % Nb and U-16.6 at. % Nb-5.6 at. % Zr) were determined in the temperature range 750 to 900°C. The creep data were fitted to an equation of the form $\dot{\epsilon} = k\sigma^n \exp(-Q/RT)$, which in turn was used to calculate stresses in oxidizing alloy specimens on the basis of elongation measurements made on the specimens during oxidation. The variation of the average stress in the oxide and in the substrate metal is given as a function of time. The details of the mechanism by which stresses are generated during the oxidation of the alloys are discussed. Comparisons of the relative creep and oxidation rates of the alloys with the stress levels observed during oxidation lead to the conclusion that at least for certain specimen geometries the differences in the mechanical properties of the oxide scales and of the parent alloys account in large measure for the differences in the oxidation characteristics of the alloys. (auth)

18768 RESISTANCE DIFFUSION BONDING BORON/ALUMINUM COMPOSITE TO TITANIUM. Hersh, M. S. (Pressure Systems, Inc., Los Angeles). Weld. J. (N.Y.); 52: No. 8, 370-376 (Aug 1973).

Resistance spot diffusion produces sound joints between boron/aluminum and titanium using standard electrodes and production welding equipment. Mechanical properties of these joints were excellent over the temperature range of 70 to 600°F. Data presented includes static, fatigue, creep, and crippling strength. (MCW)

18769 TITANIUM SCIENCE AND TECHNOLOGY. Volume 1. Proceedings of the Second International Conference, Cambridge, Massachusetts, May 2-5, 1972. Jaffee, R. I.; Burte, H. M. (eds.). Metallurgical Society of AIME Proceedings. New York; Plenum Publishing Corporation (1973). 793p. (CONF-720590-(P1)).

Volume 1 examines the extraction and refining of titanium, as well as the consolidation, fabrication, and application of this metal and its alloys. The economic implications of the use of this versatile material are explored, and such new industrial techniques as isostatic pressing and diffusion bonding are discussed. In addition, current information is presented on equipment and methods for the casting and forging of titanium and its alloys, and also on welding and other joining techniques applicable to these materials. (auth)

18770 TITANIUM SCIENCE AND TECHNOLOGY. Volume 2. Proceedings of the Second International Conference, Cambridge, Massachusetts, May 2-5, 1972. Jaffee, R. I.; Burte, H. M. (Eds.). Metallurgical Society of AIME Proceedings. New York; Plenum Publishing Corporation (1973). 660p. (CONF-720590-(P2)).

Volume 2 explores the physical—mechanical and electronic—properties of titanium and its alloys, including also problems of phase stability and phase equilibrium. The greatest part of this volume, however, is devoted to specific studies of the deformation, fatigue, and fracture characteristics of a wide variety of industrially important alloys. (auth)

18771 TITANIUM SCIENCE AND TECHNOLOGY. Volume 3. Proceedings of the Second International Conference, Cambridge, Massachusetts, May 2-5, 1972. Jaffee, R. I.; Burte, H. M. (Eds.). Metallurgical Society of AIME Proceedings. New York; Plenum Publishing Corporation (1973). 694p. (CONF-720590-(P3)).

Volume 3 reviews current research on the physical metallurgy and some aspects of the physical chemistry of titanium and titanium alloys, including problems connected with the kinetics of phase changes. The effects of thermal and mechanical treatment of the metal and its alloys are discussed, particularly as they relate to low-temperature and intermediate-temperature alloys. (auth)

18772 TITANIUM SCIENCE AND TECHNOLOGY. Volume 4. Proceedings of the Second International Conference, Cambridge, Massachusetts, May 2-5, 1972. Jaffee, R. I.; Burte, H. M. (Eds.). Metallurgical Society of AIME Proceedings. New York; Plenum Publishing Corporation (1973). 618p. (CONF-720590-(P4)).

Volume 4 continues the exploration of titanium metallurgy with a review of high-temperature alloys. Following a survey of another interesting class of materials—titanium matrix composites—the volume concludes with a series of studies of industrially significant problems of corrosion, with special emphasis on stress corrosion and hydrogen embrittlement and the application of corrosion- and wear-resistant coatings. The name and subject indexes for the four-volume set are included in this volume. (auth)

18773 VACANCY PRECIPITATION IN ZIRCONIUM ALLOYS. Carpenter, G. J. C.; Watters, J. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Acta Met.; 21: No. 9, 1207-1214(Sep 1973).

Evidence for vacancy precipitation in quenched and aged Zr-Al alloys and Zircaloy-2 was obtained using transmission electron microscopy. The resulting dislocation loops were analyzed in detail. The results indicate that the vacancy concentration in these alloys at 850°C is $\sim 4 \times 10^{-4}$. Taken with the results of a previous resistivity study using zone-refined α-zirconium, it is possible that the vacancy formation enthalpy is quite low, of the order 0.7 eV. (8 figures, 5 tables, 24 references) (auth)

18774 SUBSTRUCTURE OF TYPE 316 STAINLESS STEEL DEFORMED IN SLOW TENSION AT TEMPERATURES BETWEEN 21° AND 816°C. Michel, D. J. (Univ. of Cincinnati); Moteff, J.; Lovell, A. J. Contract AT(11-1)-2107. Acta Met.; 21: No. 9, 1269-1277(Sep 1973).

The substructure developed during slow tensile deformation was investigated by transmission electron microscopy. Cells, whose walls consist of tangled dislocations, were observed at all temperatures below $\sim 0.5T_m$ in contrast to the regular sub-boundaries and

subgrains formed above this temperature. The mean subgrain diameter, d, was found to be related to the shear flow stress, τ, at temperatures above $0.5T_m$ in accord with the recent theoretical predictions and experimental findings in the literature. However, the present results indicate that cell diameter remains relatively constant at temperatures below $\sim 0.5T_m$. From the substructure and tensile-test results, it is concluded that the deformation recovery processes which accompany the transition from Stage III to Stage IV work hardening are responsible for the sub-boundary formation observed at $\sim 0.5\ T_m$, a temperature region which also exhibits a dynamic strain aging effect. (8 figures, 45 references) (auth)

18775 TRANSITION PHASE FORMATION IN U–7.5% Nb–2.5% Zr ALLOY. Giraud-Heraud, F.; Guillaumin, J. (Societe Industrielle de Combustible Nucleaire, Vorize, France). Acta Met.; 21: No. 9, 1243-1252(Sep 1973). (In French).

The transformation process of a stabilized γ-phase uranium alloy was analyzed by electron microscopy. Some reactions previously identified in some other alloys of this type were evidenced: reactions of continuous and discontinuous precipitation of the equilibrium α phase in the upper temperature range of the T.T.T. diagram of this alloy; a bainitic reaction association with the formation of the α' transition phase in an intermediate range. In the lower-temperature range, some tweed structures were found to be associated with the formation of microdomains of the transition phases γ^3, γ^0, and then α'', explaining the observed contrast effects. These phase transformations were attributed to displacement reactions, previously evidenced in some alloys of titanium and zirconium. (17 figures, 24 references). (auth)

18776 SOLUBILITY AND TRAPPING OF HYDROGEN IN VANADIUM. Chang, H. Y.; Wert, C. A. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Acta Met.; 21: No. 9, 1233-1242(Sep 1973).

Solid solutions of hydrogen in vanadium are affected greatly by the presence of other interstitials, e.g., carbon, nitrogen, and oxygen. The solutions depart drastically from randomness at low temperatures and the solvus line is pushed to higher equilibrium hydrogen concentration as the concentration of these interstitials is increased. Utilization of internal friction and resistivity measurements permits this effect to be measured quantitatively. Two explanations are examined to interpret the results: (1) an effect of mechanical constraint of the matrix on the precipitate which acts to retard its growth. (2) an effect of clusters of hydrogen with C, N, or O to alter the equilibrium concentration of hydrogen in the free lattice, thereby altering the effective supersaturation of hydrogen. The first is considered to be inadequate to explain the full magnitude of the effect. The second can explain the effect in detail if the multi-atom clusters are assumed to exist in relatively high concentration, that is, if the binding energy per hydrogen atom is very much greater than kT. (11 figures, 3 tables, 25 references) (auth)

18777 GENERATION OF VACANCIES IN TUNGSTEN BY RAPID-RATE DEFORMATION AT ELEVATED TEMPERATURE. Armstrong, P. E. (Los Alamos Scientific Lab., NM); Green, W. V.; Sherby, O. D.; Zukas, E. G. Acta Met.; 21: No. 9, 1319-1326(Sep 1973).

Excess vacancies generated in high-purity single-crystal tungsten by rapid deformation at elevated temperatures were detected by electrical-resistivity changes following annealing treatments. Significant excess concentration of vacancies are retained only if the creep rate is greater than $10^9 D_L$ (D_L is the lattice diffusion coefficient in cm^2/sec) which is also the rate where power law breakdown begins. An activation energy of 3 eV was obtained from the resistivity annealing studies, which is in good agreement with the presently accepted activation energy for vacancy migration in ψ-tungsten. The creep rate in the power-law breakdown range is explained when an effective diffusion coefficient is introduced which includes the contributions from both mechanically generated excess vacancies and dislocation pipe short-circuit diffusion. The results obtained for tungsten imply that the activation energy for creep of pure metals in the power-law breakdown range would no longer be that for lattice self-diffusion. (24 references) (auth)

18778 MECHANICAL PROPERTIES OF INTERSTITIAL ALLOYS OF NIOBIUM. Ulitchny, M. G. Cleveland; Case Western Reserve Univ. (1972). 232p. University Microfilms Order No. 73-6346.

Thesis (Ph.D.).

The phenomenon of alloy softening in interstitial alloys of bcc metals has been attributed to a reduction in the Peierls stress, an increase in mobile dislocation density and to interactions of solute atoms. The present study was undertaken in an attempt to determine which of these possible causes actually accounts for alloy softening. Very high purity niobium (approaching one at. ppM residual interstitial) was prepared and used as the base material for a series of mechanical properties tests. This material has a reduced thermal and athermal strength, greater ductility and smaller temperature dependence of flow stress than zone refined niobium. Small additions of either oxygen or nitrogen hardened the high purity niobium over the temperature range from 77 to 500°K. The rate of alloy hardening for either binary alloy was strongly temperature dependent up to about 200 at. ppM interstitial. Above this concentration hardening was essentially athermal. The simultaneous addition of both nitrogen and oxygen in the composition range of 50 to 500 at. ppM of either or both interstitials caused alloy softening at all temperatures from 77 to 373°K. This softening is shown to result, almost exclusively, from a reduction of the thermally activatable part of the flow stress. Thus alloy softening can be ascribed to interactions of interstitials of different hardening potentials which change the number, effectiveness or distribution of thermally activatable solute barriers to dislocation motion in a way that makes such motion easier. Studies made on the activation parameters and other quantities which measure dislocation dynamics show that interstitial impurities control dislocation motion in all but the very purest of bcc metals. Corollary studies made on tantalum–oxygen–nitrogen and niobium–oxygen–hydrogen alloys show that the mechanical behavior of most, if not all, interstitial alloys of bcc metals are similar to those reported here in detail for the niobium–oxygen–nitrogen alloys. Various models which attempt to describe the low temeprature strength of bcc metals are reviewed with special emphasis on those models which take into account the effects of both extended dislocations and interstitial elements on the level and asymmetry of the flow stress. No present model adequately explains all the experimental data found. (Diss. Abstr. Int., B)

18779 FATIGUE-CRACK GROWTH IN TYPE 304 STAINLESS STEEL WELDMENTS AT ELEVATED TEMPERATURES. James, L. A. (Westinghouse Hanford Co., WA). J. Test. Eval.; 1: No. 1, 52-57(Jan 1973).

The propagation of fatigue cracks in gas-tungsten-arc weldments of Type 304 stainless steel was studied at 75 and 1000°F. It was found that the crack growth rate for cracks propagating normal to the direction of welding decreased as the crack approached the weld, and then increased as the crack grew through the weld and out the other side. It is postulated that this is due to the residual stresses produced during the welding process, and that metallurgical variations in the weldment play a minor role. (auth)

18780 NEW METHOD FOR PREPARATION OF PURE BORON BY FLUIDIZED REDUCTION OF BBr_3 IN A HYDROGEN BED. Naslain, R.; Sou-Pouyalet, B.; Etourneau, J. (Univ., Bordeaux). Mater. Res. Bull.; 8: No. 7, 825-836(Jul 1973). (In French).

Pure boron (>99%) is prepared by hydrogen reduction of BBr_3 in a fluidized bed of boron particles at a temperature of 1000°C. Fluidization is mainly controlled by flow rate and viscosity of the gas mixture and by boron particle size while the deposition rate of boron is dependent on temperature, gas composition, and mass of the bed. A rate of deposition of 1g/hour is commonly achieved in a laboratory scale apparatus. The material is obtained as granules having the α–rh. structure type and a high specific area which yields a high chemical reactivity. The main impurity is bromine (<0.5%). (auth)

18781 SOLIDIFICATION STRUCTURE AND SEGREGATION IN BINARY TITANIUM BASE ALLOYS. Nurminen, J. I. Pittsburgh; Univ. of Pittsburgh (1972). 220p. University Microfilms Order No. 73-13,218.

Thesis (Ph.D.).

The solidification behavior for a series of alloys selected from each of five binary titanium base alloy systems, Ti–Al, Ti–Fe, Ti–Ge, Ti–Mo, and Ti–V, has been examined to relate the influence of materials and casting parameters to solidification morphology and severity of microsegregation. Dendrite arm spacing and severity of microsegregation are correlated, quantitatively and qualitatively, with the materials parameters, composition, liquidus temperature, and partition ratio, and with the casting parameter, local solidification time. In addition, segregation ratio and concentration profile measurements in Ti–Fe and Ti–V alloys are correlated quantitatively with predictions generated employing a computer simulation of solidification. All alloys were prepared by nonconsumable arc melting and drop casting. To obtain a wide range of solidification times, all alloys were cast into both stepped water cooled copper molds and heated calcia stabilized zirconia molds chilled at the bottom. Local cooling rates for selected alloys were measured at three locations in both the copper chill mold and the heated ceramic mold. Measured cooling rates ranged from less than 1°C/sec to 150°C/sec at the six mold locations. Dendrite arm spacings were metallographi-

cally determined for each of the alloy compositions and plotted as a function of local solidification time, Θ_f. The dendrite spacings, d, were found to be related to the local solidification time by equations of the form $d = C\Theta_f^n$, with a value of the exponent n lying between 0.3 and 0.5 for each of the binary alloy systems. On a log-log plot, curves of dendrite arm spacing versus local solidification time for a given alloy system were approximately parallel. Within each alloy system increasing alloy element content decreased dendrite arm spacing at equivalent cooling rates. For each alloy system, the dendrite spacings were quantitatively related to alloy composition and local solidification time. Electron microprobe measurements were made on specimens of similar dendrite arm spacing for binary alloys containing 2, 5, and 10 weight percent Al, Fe, Ge, and V, respectively, and for binary alloys containing 5, 10, 15, and 30 weight percent Mo. For all samples local maxima and minima and segregation ratios were determined. In several samples as-cast solute distribution profiles (composition versus volume fraction) were determined using statistical measuring techniques. Segregation ratios were found to decrease with increasing alloy content for the systems Ti–Fe and Ti–Ge. Segregation ratios were found to decrease slightly with increasing alloy content for the systems Ti–Al and Ti–V, and to increase with increasing alloy content for the system Ti–Mo. Segregation ratios were found to decrease with increasing local solidification times for each of the alloys examined. Segregation ratios in the Ti–Fe, Ti–Mo, and Ti–V alloy systems were found to be inversely proportional to a microsegregation parameter, α, defined by the equation $\alpha = 4D_s\Theta_f/d^2$. Segregation ratios and concentration profiles were calculated for Ti–Fe and Ti–V alloys using a computer simulation of solidification. The results of these calculations agreed closely with experimental determinations for each of the six alloy compositions. (Diss. Abstr. Int., B)

18782 EMISSIVITIES OF SELECTED LANTHANIDE METALS AT TEMPERATURES ABOVE THEIR MELTING POINTS. Stretz, L. A.; Bautista, R. G. (Ames Lab., IA). pp 489–499 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 1. Preston, Thomas H. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P1).

A method is presented for experimental determination of the spectral emissivity of liquid metals by direct comparison of the surface brightness temperature to the true sample temperature. The metal sample is held in a suitable crucible and heated with an induction furnace. The brightness temperature of the surface is determined with an automatic optical pyrometer and compared to the true sample temperature which is determined by the measurement of the brightness temperature of a blackbody cavity located within the crucible. The method has been used to determine the spectral emittance of solid surfaces of yttrium, neodymium, gadolinium, and erbium and the spectral emissivities of liquid yttrium, neodymium, and gadolinium at wavelength $\lambda = 0.645\ \mu m$. Values of the spectral emittances of the solid metals depend greatly upon the surface conditions of the samples but vary only slightly with changes in temperature. Spectral emissivities of the liquid metals were found to be essentially constant with respect to temperature. For yttrium and gadolinium the spectral emittance of a clean solid surface is the same as the spectral emissivity of the liquid metal with no apparent discontinuity at the melting point. Mean values of the spectral emissivities of the liquid metals are as follows: for yttrium, $\epsilon_\lambda = 0.134 \pm 0.011$; for neodymium, $\epsilon_\lambda = 0.280 \pm 0.014$; and for gadolinium, $\epsilon_\lambda = 0.342 \pm 0.009$. (auth)

18783 INTERACTION OF MOLYBDENUM WITH ELEMENTS OF THE IRON GROUP AND CARBON. Savitskii, E. M.; Zakharov, A. M.; Burkhanov, G. S.; Kataev, R. S. pp 17–22 of Metallovedenie Tsvetnykh Metallov i Splavov. Drits, M. E. (ed). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

Data on the phase composition of molybdenum rich alloys of the Mo-Fe-C, Mo-Co-C, and Mo-Ni-C systems are examined and generalized. The influence of iron, cobalt, and nickel on the solubility of carbon in solid molybdenum is studied, together with the influence of elements of the iron group on the ductility of recrystallized molybdenum. (IAA)

18784 ALLOYS OF THE Mo–W–B SYSTEM. Shamrai, F. I.; Kharitonov, V. I. pp 22–27 of Metallovedenie Tsvetnykh Metallov i Splavov. Drits, M. E. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

The phase equilibria of the Mo–W–B system are studied by thermal, x-ray, and microstructural analysis. Isothermal cross sections obtained at 1100 and 1850°C are compared with literature data. The liquidus surface of the system is determined. The mechanical properties of MO-B and W-B alloys at 20°C are investigated. The solubility of boron in solid molybdenum is 0.0012% at 2000°C and 0.004% at 1100°C, and is 0.005% in Mo-W solid solutions at 2000°C. (IAA)

18785 INVESTIGATION OF ALLOYS OF THE MOLYBDENUM–NIOBIUM–TANTALUM SYSTEM. Priakhina, L. I.; Poliakova, R. S.; Gromova, V. G.; Miasnikova, K. P.; Ozhimkova, O. V. pp 27–31 of Metallovedenie Tsvetnykh Metallov i Splavov. Drits, M. E. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

The phase diagram of the Mo–Nb–Ta system is plotted, and the interaction between these elements is studied. The composition/hardness diagram of alloys of this system is investigated at temperatures ranging from 20 to 1100°C. The constitution equilibrium diagram is obtained. A complete mutual solubility of the system components is established. Tantalum additions are shown to produce a better strengthening effect in molybdenum and its alloys than niobium additions. (IAA)

18786 PHASE EQUILIBRIA IN THE ALUMINUM–CHROMIUM–ZIRCONIUM SYSTEM. Kadaner, E. S.; Kuz'mina, V. I. pp 41–44 of Metallovedenie Tsvetnykh Metallov i Splavov. Drits, M. E. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

18787 TEMPERATURE DEPENDENCE OF THE SOLUBILITY OF SCANDIUM IN SOLID MAGNESIUM. Sviderskaya, Z. A.; Nikitina, N. I. pp 61–65 of Metallovedenie Tsvetnykh Metallov i Splavov. Drits, M. E. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

The solubility of scandium at 300, 400, 500, and 600°C is studied by microstructural phase analysis, using deformed and annealed magnesium samples containing 32% Sc. It is shown that the 22-wt % solubility of rhenium at 600°C decreases to 13 wt % at 300°C. The solubility of scandium at 706°C (invariant transformation temperature) is found to equal 26 wt % (16 at. %) (IAA)

18788 FRACTURE CHARACTERISTICS OF THERMALLY STRENGTHENED TITANIUM BETA ALLOYS. Novikov, I. I.; Kasparova, O. V. pp 147–150 of Metallovedenie Tsvetnykh Metallov i Splavov. Drits, M. E. (ed.). Moscow; Izdatel'stvo Nauka (1972). (In Russian).

Tensile test data obtained with rod and sheet samples of a titanium-molybdenum alloy (20 wt % Mo) and the VT 15 titanium alloy (2.6 wt % Al, 6.8% Mo, 9.5% Cr, 0.10% O, and 0.005% H) tempered from 850 and 900°C and aged at 450, 500, and 680°C are analyzed. It is shown that microcracks develop and propagate at the grain boundaries. (IAA)

18789 ROOM-TEMPERATURE BEND STRENGTH OF ALPHA-PLUTONIUM. Lundberg, L. B. (Los Alamos Scientific Lab., NM). J. Nucl. Mater.; 47: No. 3, 347–351 (Jul 1973).

A four-point bend fixture was used to measure the modulus of rupture at room temperature for five specimens of unalloyed α-Pu. The modulus of rupture was determined to be 6590 ± 1050 kg/cm^2 (93,800 ± 15,000 psi). Fractured specimens were examined by metallography and fractography; although the failure appeared to be brittle, the predominant failure mode is ductile-transgranular with a very limited ductility. Fractography indicates that the microdefects act as major failure initiation points. (DLC)

18790 STRAIN AGING OF QUENCHED ZIRCALOY-2. Veevers, K.; Snowden, K. U. (Australian Atomic Energy Commission, Lucas Heights). J. Nucl. Mater.; 47: No. 3, 311–316 (Jul 1973).

The strain-aging behavior of quenched Zircaloy-2 was studied in the temperature range 150 to 475°C. Quenching from 750°C enhanced the strain-aging response at 300°C and suppressed it at ~450°C compared with the behavior of annealed and slow-cooled Zircaloy-2. Increasing the quenching temperature in the range 750 to 850°C increased the strain-aging response at all test temperatures. The yield stress and tensile strength increased with quenching temperature, whereas the ductility was decreased. The enhanced strain aging at 300°C is thought to be due to the presence of interstitial–interstitial atom pairs. The suppression of strain aging at ~450°C is considered to be due to trapping of Fe atoms by quenched-in defects. (auth)

18791 MAGNETIC TO NONMAGNETIC TRANSITION OF CERIUM IMPURITIES IN (La, Th) ALLOYS. Ortega, S. (Univ. Chile, Santiago); Roth, M.; Rizzuto, C.; Maple, M. B. Solid State Commun.; 13: No. 1, 5–7 (1 Jul 1973).

The initial depression of the superconducting transition temperature of (La, Th) Ce alloys was measured. It was found that there is a steep maximum in the initial depression as a function of La concentration in the (La, Th) matrix. This effect is com-

pared with the nonmonotonic behavior of the critical temperature of LaCe under pressure. (auth)

18792 TEST RESULTS OF STRUCTURAL MATERIALS FOR IN-PILE AND OUT-OF-PILE HIGH-TEMPERATURE HELIUM GAS LOOPS. Nomura, S. (Japan Atomic Energy Research Inst., Oarai); Itami, H.; Yamamoto, K.; Muraoka, S.; Fujimura, T. Paper No. 15. Tokyo; International Nickel Japan Ltd. (1972). vp. (In Japanese).

From international nickel power conference; Kyoto, Japan (28 Nov 1972).

Various kinds of materials feasibility tests have been performed for high temperature helium loop application in JAERI. The high temperature part of the in-pile loop, OGL-1, has double wall tube structure in which Hastelloy-X is used as temperature boundary tube material and AISI 316 stainless steel as pressure tube material; insulating material is inserted between both tubes. To absorb thermal expansion of high temperature tube, both bellow and slide joints are tested. In the slide joint, vaarious kinds of ceramics were spray-coated on Hastelloy-X plates, then compatibility and endurance tests of these ceramic coated plates were carried out. Irradiation experiments on mechanical properties of Hastelloy-X are being carried out at high temperature up to 1000°C in JMTR. Out of pile creep test of the alloy in air and in helium is also being carried out. Compatibility experiments of Hastelloy-X with other heat resistant alloys, refractory metals and graphite were performed. The results indicate that all heat resistant alloys tested showed no adhesion with Hastelloy-X. Carburization of Hastelloy-X in contact with graphite block is examined for up to 1000 hours in pure helium between 800 and 1000°C, and change of mechanical properties of Hastelloy-X was measured. Results of the experiment indicate that carburization penetration depth is not deep in Hastelloy-X in this environment, and that difference in mechanical properties of Hastelloy-X with and without graphite contact is nominal. Corrosion of various kinds of heat resistant nickel alloys in helium at high temperature up to 1100°C was tested, and Hastelloy-X was proved to be the most corrosion resistant alloy among those tested. Corrosion test of Hastelloy-X in flowing helium is under way at 1000°C. (auth)

18793 DIFFUSION OF CARBON IN BERYLLIUM OXIDE. Gladkov, V. P.; Zotov, V. S.; Skorov, D. M. At. Energ. (USSR); 34: No. 4, 290-291(Apr 1973). (In Russian).

The diffusion of ^{14}C in sintered BeO in a vacuum was studied over the temperature range 1250 to 1800°C. The limits of the respective carbon diffusion coefficients were 6×10^{-12} and 1.6×10^{-9}. The data were in agreement with those of ^{7}Be diffusion in BeO. (KSW).

18794 COMPARATIVE BEHAVIOR OF COPPER ALLOYS: TIN BRONZES AND BRASSES CONTAINING VARIABLE AMOUNTS OF BERYLLIUM. Garrigo, F.; Roig, J. ATF Colada; 3: No. 12, 710-715(Dec 1970). (In Spanish).

The effects of adding Be 0.40 to 1.70% to 60:40 brass and 90:10 Sn-bronze on their properties are described, with particular reference to the influence of Be on the microstructure, mechanical properties, specific conductivity, and resistance to corrosion at elevated temperatures. The amount of Be added directly affects Sn diffusion, and the hardness of brasses and bronzes is a direct function of the Be content. Corrosion and heat resistance are improved in some cases. (Metals Abstr.)

18795 APPLICATION OF FRACTURE MECHANICS TO NUCLEAR PIPING SYSTEMS. Senchak, W. E.; Widera, O. E. Eng. Fracture Mech.; 4: No. 4, 877-892(Dec 1972).

Nuclear piping systems are examined from a fracture-mechanics viewpoint with consideration being given to the present ASME standards. Critical crack lengths and crack growth for a typical mainstream pipe are calculated, and the "pipe-whip" phenomenon is also discussed. (Metals Abstr.)

18796 THERMAL DECOMPOSITION OF $PrCo_2$ AND $NdCo_2$ UNDER ULTRAHIGH VACUUM. Farmar, P. D.; Lawson, A. C. (Univ. of California, San Diego). Phys. Lett. 44A: No. 1, 1-2 (7 May 1973).

Results of experiments involving outgassing of cubic Laves phases of $PrCo_2$ and $NdCo_2$ at 950°C and 2×10^{-9} torr are presented which show that $RECo_2$ (RE = rare earth) decomposes with the reaction $RECo_2 \rightleftharpoons RECo_3 + RE$. (JRD)

18797 MECHANICAL PROPERTIES OF MOLYBDENUM BICRYSTALS. Kopetskii, Ch. V.; Pashkovskii, A. I. (Inst. of Solid State Physics, Moscow). Dokl. Akad. Nauk SSSR; 210: No. 1, 72-74(1 May 1973). (In Russian).

The dependence of Mo bicrystal bending characteristics on the degree of disorientation was investigated. Bends up to 180° at room temperature did not lead to their distruction provided certain disorientation limits were observed. (KSW).

18798 DYNAMIC PLASTICITY: MACROSCOPIC AND MICROSCOPIC ASPECTS. Campbell, J. D. (Oxford Univ.). Mater. Sci. Eng.; 12: 3-21(1973).

A brief account is given of theoretical treatments of plastic deformation based on considering the material as a continuum or as a crystalline solid in which flow occurs by the motion of dislocations. Theoretical and experimental work on stress-wave propagation in rate-independent and rate-dependent materials is also discussed. The available experimental methods for the study of strain-rate effects are described, and results are given for a variety of metals and alloys tested at strain rates covering some eight orders of magnitude. These results are discussed in terms of some of the more important rate-controlling mechanisms. Attention is drawn to several important practical problems in which rate-dependent mechanical behavior is significant, and suggestions are made concerning areas in which further studies are desirable. (auth)

18799 TEMPERATURE DEPENDENCE OF THE HEAT CAPACITY OF SCANDIUM. Sirota, N. N.; Kudel'ko, Zh. M. (Inst. of Solid State Physics and Semiconductors, Minsk). Dokl. Akad. Nauk SSSR; 209: No. 5, 1068-1070(11 Apr 1973). (In Russian).

The heat capacity of Sc was determined as a function of temperature from 3 to 300°K. From these data a table of values for C_p, C_v, $-(F - U_o)$, ΔS, and $-(Z - H_o)$ was prepared for the temperature range 10 to 300°K. (KSW).

18800 INTERRELATION BETWEEN HEATS OF MIXING AND MOLAR VOLUME CHANGES IN THE FORMATION OF LIQUID BINARY ALLOYS. Kryshtab, T. G.; Lenichenko, V. A.; Khar'kov, E. I.; Shvets, S. V. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 18: No. 3, 681-683(Apr 1973). (In Russian).

A study was made of the relation between heats of mixing (ΔH) and changes in the molar volume ($\Delta V/V$) in various binary metal mixtures at 400°C. In all the systems studied—maxima in the quantities measured were observed in the interval 40 to 60% of one of the components. (KSW).

18801 STUDY OF Zr–Mo–Cu ALLOYS. Zapletalek, A. (Vyskumny Ustav Zvaracsky, Bratislava). Hutn. Listy; 27: No. 9, 651-657(Sep 1972). (In Czech).

Properties were investigated of a series of Zr–Mo–Cu alloy samples containing Mo 0.5 to 1.2 and Cu 0.5 to 0.8%: allotropic transformation points, thermal expansion coefficient, plasticity after hot and cold forming, and structural morphology. The transformation points C_1, C_2, R_1, and R_2 were found to equal 775, 851, 739, and 790°C, respectively. The thermal expansion coefficient was tabulated for temperatures between 20 and 700°C for both temperature increases and decreases. The plasticity showed differences in hardening. Cross-rolled samples were less hardened than those rolled longitudinally. The mechanical strength of the hardened samples decreased, while their ductility increased two or three times. X-ray analysis indicated texture in the samples and in additions to α-Zr, lines were found corresponding to cubic $ZrMo_2$ and tetragonal Zr_2Cu. The mechanism and kinetics of transformation showed considerable difference from the austenite transformation in steel. The morphological variety of the transformation products was considerably affected by the presence of air. (INIS)

18802 MEASUREMENTS OF BINARY LIQUID ALLOYS ELECTRICAL RESISTIVITY. Bernabai, U.; Gauzzi, F. (Univ., Rome). Met. Ital.; 65: No. 3, 129-132(Mar 1973). (In Italian).

Electrical resistivity and its temperature coefficient measurements were carried out on binary liquid alloys In–Tl, Bi–Cd, Cd–In, and Bi–In. The experimental values of the resistivity temperature coefficient do not agree with theory. A hypothesis is advanced on the presence of two kinds of clusters into the liquid alloys: one corresponding to intermediate phases or intermetallic compounds and the other to the eutectic, the first being more stable with temperature increase. (auth)

18803 TWINNING PROCESSES IN BERYLLIUM AND ITS ALLOYS WITH COPPER. I. Bashmakov, V. I.; Papirov, I. I.; Yakovenko, N. G. (Kharkov Inst. of Public Power). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 104-108(1972). (In Russian).

Mechanical twinning was studied in crystals of pure Be (99.99%) and in alloys of Be–0.4 at. % Cu and Be–2.3 at. % Cu. Yield limits in single twin were measured and the behavior of twin faces in pulsed and alternating loading was examined. The concentration dependence of yield limits of single crystals facilitated an evaluation of the energy of interaction of twinning dislocations with atoms of the added element. The Bauschinger

effect was manifest on the faces of mechanical twins, the characteristics of which depended on the solution angle of the twin wedge, the concentration of the admixed element, and the number of cycles of retwinning. (tr-auth)

18804 X-RAY MEASUREMENTS OF LATTICE EXPANSION AS METHOD FOR DETERMINING DIFFUSION COEFFICIENTS OF HYDROGEN IN TANTALUM. Zuechner, H. Z. Phys. Chem. (Frankfurt); 82: No. 5-6, 240-255(1972).

Diffusion of H in Ta is monitored by x-ray measurements based on the principle that the lattice parameter a equals $a_0(1 + 0.05n)$, where a_0 is the lattice parameter of pure Ta and n is the atomic ratio in TaH . Concentration profiles were measured at 30, 58, and 85°C. The diffusion coefficient at 25°C for decreasing H concentration $D^{298}_{n\to 0} = (1.8 \pm 0.2) \times 10^{-6} cm^2/s$. Activation energy was independent of concentration in the range $0 \le n \le 0.07$ and had a value of 3.5 ± 0.25 kcal/mole. (27 references) (Metals Abstr.)

18805 AGING OF TITANIUM ALLOY VT9. Kryuchkova, A. I.; Gromov, G. A. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 1024(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 11, 77(Nov 1972).

The effects of prolonged holding (500 h) at 450 and 500°C on the properties of alloy VT9 (6.9% Al, 3.04% Mo, 1.65% Zr, 0.28% Si, 0.11% Fe, 0.085% C, 0.006% H, 0.05% N) were studied. It was found that after aging of alloy VT9 at 450 and 500°C the strength increases slightly (1 to 4 kg/mm^2). The ductility of the alloy decreases with aging. Aging of finished samples at 500°C reduces the impact toughness. The strength of notched samples, aged in finished form, decreases, depending on the aging temperature. (auth)

18806 MAGNETIC POWDER METALLOGRAPHY OF BORIDED STEELS AND IRON–BORON ALLOYS. Kulik, A. Ya. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 1042-1045(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 12, 12-14(Dec 1972).

The structure and phase composition of iron and its alloys were investigated by the method of magnetic powder metallography. A suspension of magnetic powder was prepared from Fe_3O_4. The mixture (1.75 g powder +0.25 g baby soap +5 – 7 g distilled water) was thoroughly ground, thinned with 40 to 45 g distilled water, and boiled 10 to 15 min with stirring, after which another 100 g of distilled water was added and it was boiled with continuous stirring for 5 to 7 min. The suspension was allowed to settle and then filtered several times. The studies were made on Armco iron and steels 20, 45, U8 and 40S4 borided in a solution of 70% borax and 30% boron carbide at 950°C for 3 h, followed by cooling in air, and also on an alloy of 92% Fe + 8% B. The magnetic powder study of carbon steels showed that aging of the boride coating has little effect on the carbon content. The apparent reduction of the "needle-likeness" of borides in steel U8 after etching as compared with steels 20 and 45 is due to the presence of boron-enriched cementite, carbides, and other weakly magnetic phases in the boride case. The magnetic powder study of borided silicon steel 40S4 revealed the fine structure and phase composition of the transition zone (α-solid solution). Etching does not reveal the subgrain structure of the α-phase, while the magnetic powder study reveals the block structure of the α-phase. As the metallographic study of electrolytically borided steel 40S4 showed, the α phase consists of two layers — α' phase located primarily between boride needles and α'' phase below the α' phase. After liquid nonelectrolytic boriding, metallographic analysis does not reveal the fact that the transition zone consists of two phases. The magnetic powder study showed that the α phase consists of two phases with different silicon concentrations. (JRD)

18807 AGING OF Mo–Re–C ALLOYS. Savitskii, E. M.; Tylkina, M. A.; Konieva, L. Z.; Morgunova, N. N.; Sorokin, A. N. (Inst. of Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 931-934(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 11, 2-4(Nov 1972).

The aging process in alloys Mo–0.08 C–0.4 Zr and Mo–45 Re–0.06 C–0.4 Zr was investigated. The maximum aging is observed in alloy Mo 0.08 C 0.4 Zr at 1400 to 1800°C, and in alloy Mo 45 Re 0.06 C 0.4 Zr at 1400 to 1600°C. As the result of the increase in the solubility of carbon in molybdenum in the presence of rhenium (45%) the aging process is most intense in alloy Mo–0.08 C–0.4 Zr. (auth)

18808 STRUCTURAL CHARACTERISTICS OF SURFACE LAYERS IN SHEETS OF MOLYBDENUM ALLOYS. Zueva, I. B.; Mezhennyi, Yu. O.; Skakov, Yu. A. (Moscow Inst. of Steel and Alloys). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 935-938(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 11, 5-8(Nov 1972).

The structural characteristics of the zone in which recrystallization is inhibited in samples of rolled molybdenum alloys with 0.004% C, 0.1% Ti, and 0.1% Zr and with 0.004% C and 0.1% Zr were investigated. It was found that dissimilar strain hardening of the surface layer and the bulk of rolled molybdenum alloys results in a structurally nonhomogeneous condition after deformation — a cellular structure in the bulk of the material and a fine polygonal structure in a surface layer 0.1 mm thick. At the interface of the structurally dissimilar layers, characterized by a high density of randomly distributed dislocations, orientational microdistortions occur. During annealing the distortions are removed at the interface, and an equilibrium structure is formed by different means by recrystallization in the bulk and by a process competing with recrystallization in the surface. Polygonization is the main reason for retention of a layer that is difficult to recrystallize during annealing. (JRD)

18809 RECRYSTALLIZATION OF TUNGSTEN ELECTRON-BEAM MELTS WITH ADDITIONS OF TANTALUM AND ZIRCONIUM CARBIDE. Malytsev, M. V.; Naumkin, O. P.; Nemirovskaya, F. S.; Mikhailov, V. G. (All-Union Scientific-Research and Design Inst. of Refractory Metals and Hard Alloys, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 939-942(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 11, 8-11(Nov 1972).

The recrystallization of deformed semifinished products of electron-beam melts of W with added Ta and ZrC was investigated. It was found that the initial recrystallization temperature of the tungsten alloy is 1600 to 1700°C, depending on the degree of deformation. Recrystallization is complete at 1800°C for 1 h at all degrees of deformation investigated. A fine-grained recrystallized structure is retained at 1800 to 1900°C. The initial temperature of secondary recrystallization is 2000°C. Additions of zirconium carbide and tantalum prevent secondary recrystallization up to temperatures at which excess carbides are dissolved (2000°C) and also prevent growth of tungsten at critical degrees of deformation. (JRD)

18810 EFFECT OF HEAT TREATMENT ON STRUCTURE AND PROPERTIES OF ALLOY NV10M5T3Ts. Prokoshkin, D. A.; Vasil'eva, E. V.; Markova, S. A. (Moscow Technical Coll.). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 943-945(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 11, 11-14(Nov 1972).

The investigation was conducted using an Nb-base alloy containing 9.4% W, 5.98% Mo, 2.75% Ti, 1.65% Zr, 0.05% C, 0.02% N, and 0.001% H. It was found that quenching from 1700°C is an effective method of hardening this alloy. The high strength of the alloy results from the formation of a multicomponent solid solution with strong interatomic bonds and the precipitation of refractory carbides during subsequent aging. (JRD)

18811 ELECTROTHERMAL TREATMENT OF MOLYBDENUM. Bogatyrev, Yu. M.; Figel'man, M. A. (Central Scientific-Research Inst. of Technology and Mechanical Engineering, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 11-12, 982-984(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 11, 48-50(Nov 1972).

Methods and results of electrothermal heating of plates and tubing of Mo alloys VM1 and TsM2A are reported. Rapid electrothermal treatment can be used for thin-walled molybdenum parts to improve the ductility of the material after cold deformation. To improve the ductility of cold-worked molybdenum alloys VM1 and TsM2A the following electrothermal treatment is recommended: heating at the rate of 50 to 100°/sec in vacuum of 1×10^{-3} to 2×10^{-5} mm Hg to 1800°C without holding. (JRD)

18812 PROPERTIES OF FINE BERYLLIUM WIRE. Babkina, M. A.; Zhermunskaya, L. B.; Timofeeva, Z. A.; Tsukanova, N. V. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 7-8, 674-676(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 8, 21-23(Jul 1972).

The physicomechanical properties of small-diameter Be wires were investigated. It was found that maximum strength and optimum elastic characteristics in Be wire are achieved by subcrystallization tempering at 300 to 400°C after hot drawing. (JRD)

18813 DEPENDENCE OF MAGNETIC PROPERTIES OF SINTERED $SmCo_5$ AND $Sm_{0.5}Pr_{0.5}Co_5$ ALLOYS ON ANNEALING TEMPERATURE. Shcherbakova, E. V.; Ermolenko, A. S.; Shur,

Ya. S. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 35: No. 3, 655-659(1973). (In Russian).

The effects of repeated annealing on the properties of sintered magnets of $SmCo_5$ and $Sm_{0.5}Pr_{0.5}Co_5$ were investigated in the temperature range 500 to 1130°C. The coercive force and the demagnetization characteristics of these alloys were measured as functions of annealing temperature. (KSW)

18814 MICROSTRUCTURE AND MECHANICAL PROPERTIES OF EUTECTIC Ni_3Al-Ni_3Nb. Kotov, V. F.; Kurilo, Yu. P.; Somov, A. I.; Shvarts, V. I. (Moscow State Univ.). Fiz. Metal. Metalloved.; 35: No. 3, 669-672(1973). (In Russian).

A pseudobinary eutectic forms between the phases $Ni_3Al(\gamma')$ and $Ni_3Nb(\delta)$ and has the composition Ni–23.1 wt % Nb–4.4 wt % Al. The microstructure and high-temperature strength of the two component alloys and their eutectic were studied. Controlled crystallization made it possible within wide limits to control the mechanical properties of the eutectic composition. (KSW)

18815 INFLUENCE OF RECOVERY HEAT TREATMENTS ON THE LOW-TEMPERATURE DUCTILITY OF Fe–V ALLOYS. Jellison, J. L.; Stoloff, N. S. (Rensselaer Polytechnic Inst., Troy, NY). Mater. Sci. Eng.; 12: 35-39(1973).

The influence of cold working, followed by recovery heat treatments, on the ductility of several binary Fe–V alloys was examined at test temperatures between 4.2 and 300°K. An improvement in ductility relative to the fully recrystallized condition was observed at temperatures below 100°K for all alloys. A lowering of the fracture mode transition temperature with the recovered microstructure is deduced from fractographic observations. The observed shifts in ductility and fracture mode are attributed to the formation of a stable dislocation substructure during the recovery heat treatments. (auth)

18816 POLYGONIZATION IN POLYCRYSTALLINE VANADIUM. Dubovitskaya, N. V.; Lapikov, L. N. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 35: No. 4, 779-784 (1973). (In Russian).

Electron-microscope studies of polycrystalline vanadium were made under contrasting conditions and temperatures of deformation and annealing. Essential differences were observed in comparison with Mo, both in the formation of polygonized subgrains, and in their growth. An extremely slow subgrain formation and a difference in growth kinetics was explained by a small value of packing defect energy in V in comparison with Mo. (tr-auth)

18817 INFLUENCE OF COBALT ON THE AGING MECHANISM OF MARTENSITE-AGING STEELS. Kablukovskaya, M. A.; Mogutnov, B. M. (Inst. of Metal Science and Physics of Metals, Moscow). Fiz. Metal. Metalloved.; 35: No. 4, 791-795(1973). (In Russian).

The introduction of Co into martensite-aging alloys of the Fe–Ni–Mo system led not only to an increase in the quantity of released intermetallic phase, but altered the mechanism of aging at low temperatures. Processes associated with the interaction of Mo atoms with defects in the crystalline structure of martensite also contributed significantly to the low-temperature thermal effects. (tr-auth)

18818 INFLUENCE OF PURITY AND TEMPERATURE ON CRITICAL SHEAR STRESS IN ZINC AND CADMIUM SINGLE CRYSTALS. Vladimirova, V. L.; Lavrent'ev, F. F. (Physical Technical Inst. of High Temperatures, Kharkov). Fiz. Metal. Metalloved.; 35: No. 4, 801-806(1973). (In Russian).

The temperature dependence of the critical shear stress was determined for single crystals of Zn (purity 99.99 and 99.999%) and Cd (purity 99.98%) during simple shear in the slippage system $(0001)\langle 11\bar{2}0\rangle$ over the temperature range 1.4 to 300°K. The critical shear stress in 99.999% Zn was practically independent of temperature. An anomalous temperature dependence of the critical shear stress was observed for 99.99% Zn and Cd, and the relaxation of stress was absent over the range 1.4 to 50°K. (tr-auth)

18819 INTERNAL FRICTION OF NIOBIUM QUENCHED FROM PREMELTING TEMPERATURES. Arkelov, A. G.; Blanter, M. S.; Kissil, A. E.; Kovaleva, L. A.; Stekachev, I. T. Fiz. Metal. Metalloved.; 35: No. 4, 826-831(1973). (In Russian).

Measurements of internal friction and elastic after-effects showed that in Nb with 0.4 at. % oxygen, after quenching from a premelting temperature, about 6% of the total dissolved oxygen was adsorbed at the defects and reverted to the solid solution after annealing at 200 to 400°C. An explanation is offered on the basis of complex formation of O and V atoms; the energy involved was estimated as 0.2 eV, and the activation energy of its motion 0.8 eV. (tr-auth)

18820 SUPERCONDUCTING TRANSITION TEMPERATURE IN COMPOUNDS WITH β-TUNGSTEN STRUCTURE. Izyumov, Yu. A. (Inst. of Metal Physics, Kazan). Fiz. Metal. Metalloved.; 35: No. 4, 687-698(1973). (In Russian).

The density of the state for d-electrons in crystals with the β-tungsten structure was calculated for the conditions in which the matrix element of transition from chain to chain was small in comparison with movement along the chain. Using these data, the transcendental equations for T_c were solved. It was found that nonmagnetic mixtures lead to a change in the effective interchain interaction parameter and thus bring about a lowering of T_c. (tr-auth)

18821 TEMPERATURE DEPENDENCE OF YIELD STRENGTH OF TEXTURED BERYLLIUM. Tikhinskii, G. F.; Khristenko, I. N. (Physical-Technical Inst., Kharkov). Fiz. Metal. Metalloved.; 35: No. 4, 865-867(1973). (In Russian).

The yield limits of textured Be (~99.95% pure) were studied as a function of the temperature from –200 to +500°C. The flow stress of the same Be was measured over the temperature range –60 to +130°C for different degrees of deformation. (KSW)

18822 DIFFUSION IN COMPOSITE MATERIALS. Blinkin, A. M.; Ozhigov, L. S.; Miroshnichenko, Yu. T.; Khrinkov Yu. F.; Semenenko, V. E. (Kharkov State Univ.). Fiz. Metal. Metalloved.; 35: No. 4, 870-872(1973). (In Russian).

The ratio of the diffusion coefficients of Ni in the two composites Cu–W and Cu–Mo to the diffusion coefficient in pure Cu (D/D_{Cu}) was studied in relation to the bulk content of the reinforcing phase from 0 to 40%. The experiments were conducted at 700°C, and the W and Mo were present in the Cu in the form of wire. (KSW)

18823 INFLUENCE OF A MAGNETIC FIELD ON THE MINIMUM VALUE OF THE ELECTRICAL RESISTANCE OF PRASEODYMIUM. Semenenko, E. E.; Tutov, V. I. (Physical-Technical Inst., Kharkov). Fiz. Metal. Metalloved.; 35: No. 4, 892-893 (1973). (In Russian).

The effect of external longitudinal magnetic fields of different intensities on the temperature dependence of the electrical resistance of Pr was studied over the temperature range ~2 to 4°K. At any given temperature the absence of a magnetic field yielded the smallest resistance. The value of $R_{4°K} - R_{1.8°K}/R_{4°K}$ was 2.07, 1.06, and 0.75%, corresponding to field intensities of 0, 45, and 60 kOe. (KSW)

18824 CHANGE IN DISLOCATIONAL STRUCTURE OF VACUUM CONDENSATES OF TUNGSTEN DURING THERMAL CYCLING. Yaroshevich, P. Yu.; Belomyttsev, Yu. S. Fiz. Metal. Metalloved.; 35: No. 4, 849-851(1973). (In Russian).

Single crystals of W condensates 50μ in thickness were obtained by electron beam sublimation and condensation in a vacuum at 10^{-6} mm Hg, and were subjected to thermal cycling at 800 to 1500°C at a heating rate of 1400°/min and a cooling rate of 850°/min. The density of dislocations in the W crystals was determined as a function of the number of thermal cycles; above 400 cycles the single crystals were converted into polycrystalline W. (KSW)

18825 KNIGHT SHIFT IN COMPOUNDS OF COBALT WITH TRANSITION METALS. Kalantaryan, V. P.; Chechernikov, V. I. (Moscow State Univ.). Fiz. Metal. Metalloved.; 35: No. 4, 855-856(1973). (In Russian).

The electronic structure of Co–transition metal alloys was studied by measuring the Knight shift and magnetic susceptibility of CoTa, CoNb, CoV, and CoTi. The large orbital paramagnetic susceptibility for all four compounds suggested that the orbital motion of d electrons plays a basic role in the creation of a supplementary field at the ^{59}Co nuclei. (KSW)

18826 ENERGY SPECTRUM OF CONDUCTION ELECTRONS IN TERNARY SOLID SOLUTIONS. Osipovaa, S. G.; Pryadein, V. I.; Shtol'ts, A. K.; Stepanov, A. P.; Prekul, A. F.; Gel'd, P. V. (Ural Polytechnical Inst., Sverdlovsk, USSR). Fiz. Metal. Metalloved.; 35: No. 4, 841-844(1973). (In Russian).

The concentration–temperature dependencies of the magnetic susceptibility and Knight shift were measured for the ternary alloys $(V_{1-x}Cr_x)_3Ge$, where $x = 0, 0.05, 0.15, 0.25, 0.30, 0.35, 0.40, 0.50, 0.70, 0.75$, and 1.00. Experimental data obtained in a transition temperature study at the temperature of the superconducting state are discussed. (KSW)

18827 INTERNAL NITRIDING OF MOLYBDENUM ALLOY VM-4. Levinskii, Yu. V.; Buntushkin, V. P. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 9-10, 918-919(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 10, 73-74(Oct 1972).

The effect of internal nitriding on the properties of molybdenum alloy VM-4 wire was investigated. The VM-4 alloy contained a small amount of titanium (0.2%) and zirconium (0.2 to 0.3%) not combined in carbides. The short-term strength at 1100 to 1400°C was determined on strain-hardened and recrystallized wire and also wire nitrided after recrystallization, and the long-term strength at 1100°C was determined in the latter two cases. The relatively high heat resistance obtained by internal nitriding of Mo wire with a recrystallized equiaxed structure permits use of this wire for strengthening heat resistant composite materials based on nickel, but the drawback involves its low recrystallization temperature due to the interaction of the wire with nickel and the associated weakening. (MCW)

18828 NIOBIUM IN HEAT-RESISTANT STEELS AND ALLOYS. Zimina, L. N. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 9-10, 896-920(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 10, 57-63(Oct 1972).

The effect of niobium on the properties of heat-resistant steels and alloys may differ in relation to its interaction with elements in the alloy (the formation of carbides, intermediate compounds, and other phases, or alloying of the solid solution). In austenitic steels with a low C content, Nb forms Fe_2Nb, increasing the hardness and long-term strength. The addition of Nb to Cr–Ni steels of the 18-8, 23-12, and 25-20 types accelerates the formation of σ phase. Niobium is added to several scale-resistant steels and alloys and cobalt-base alloys, alloying the solid solution. The strength of Ni–Nb alloys at high temperatures increases continuously with the Nb content, while the ductility and toughness decrease correspondingly. The Ni–Nb–Al system as a base for high heat-resistant alloys is considered. Cr–Ni alloys with a high niobium content have been studied. The addition of niobium to high heat resistant alloys with a large aluminum content results in high resistance to the influence of combustion products of natural gas and diesel fuel in prolonged operation at high temperatures and stresses. The development of commerical alloys with the optimal ratio of alloying elements has demonstrated that the use of niobium results in excellent weldability, especially the resistance to cracking during welding or heating of welded joints; high resistance to gas corrosion during prolonged exposure to combustion products of natural gas and diesel fuel; a combination of high heat resistance and long-term ductility; and the possibility of producing precision castings of high quality in air, since it prevents film formation. (23 references) (MCW)

18829 PROPERTIES OF Cu–Nb ALLOYS. Nikolaev, A. K.; Rozenberg, V. M. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 9-10, 888-890(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 10, 50-53(Oct 1972).

The variation of the mechanical properties, heat resistance, and electrical conductivity of low-alloy Cu–Nb alloys with composition, heat treatment, and testing temperature were investigated. Ingots of the alloys with up to 1.5% Nb were melted in a high-frequency vacuum induction furnace from M00 cathodic copper and a Cu–Nb master alloy (4.7% Nb). Test samples were prepared after hot and cold rolling with total reduction around 50% in each case. The initial rolling temperature was 900 to 920°C. Wire was drawn with intermediate annealing at 680 to 700°C for 2 h. Results show that the properties of Cu–Nb alloys do not depend on the heat-treatment conditions, which distinguishes the alloys of this system from most of the thermal conducting and electrical conducting alloys used at the present time. With increasing concentrations of niobium the red hardness of the alloys increases continuously and exceeds that of copper by a factor of 2 to 3. The electrical conductivity decreases slightly. Copper alloys with 0.2 to 0.75% Nb can be recommended for parts and structures in a wide range of operating temperatures where heat treatment is technically difficult or impossible. (MCW)

18830 EFFECT OF COBALT ON AGING OF MARTENSITE IN Fe–Ni–Mo ALLOYS. Perkas, M. D.; Gruzin, P. L.; Edneral, A. F.; Mogutnov, B. M.; Rodionov, Yu. L.; Eremenko, M. A. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 9-10, 837-844(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 10, 2-10(Oct 1972).

The effect of cobalt on hardening of martensite in Fe–Ni–Mo alloys was determined by electron microscopic and calorimetric investigations and study of the redistribution of atoms of alloying elements during aging by the nuclear gamma resonance method. The reasons for the effect of cobalt on hardening of alloys with molybdenum have not been consistent in previous experimentation. A corresponding increase of the Mo content in Fe–Ni–Mo alloys in amounts at which the amount of Mo precipitating from the solid solution was the same as in alloys with cobalt did not lead to substantial additional hardening. It is then assumed that cobalt not only reduces the solubility of Mo in the alpha phase but also changes the mechanism of decomposition of the solid solution. Special study was made of the initial stages of decomposition of the solid solution by the various methods. Results indicate that the addition of cobalt to maraging Fe–Ni–Mo alloys not only increases the volume percent of intermetallic phase but also changes the decomposition mechanism of the solid solution at certain concentrations. At low aging temperatures metastable precipitates rich in molybdenum and, evidently, nickel are formed, with the structure of ω-phase. The formation of this phase is favored by the formation of regions with short-range order of the Fe–Co type at low temperatures. All these processes affect to some extent the increase of the resistance to plastic deformation of aged Fe–Ni–Co–Mo alloys. (MCW)

18831 FERROELASTIC AND SUPERELASTIC BEHAVIOR IN Ag–Cd ALLOYS. Mura, S. (Doshisha Univ., Kyoto); Mori, T.; Nakanishi, N. Scr. Met.; 7: No. 7, 697-700(Jul 1973).

Pseudoelastic properties found in Ag–Cd alloys are reported. Data on variation of the tensile stress–strain curve with temperature in Ag–Cd alloys containing 44 and 45 at. % Cd are presented along with data on variation of yield stress for stress-induced transformation in this alloy. The ferroelectric limit in this alloy was found to be 10 to 13 kg/mm^2. (JRD)

18832 HIGH-SPEED (MILLISECOND) SYSTEM FOR STUDIES OF PHASE TRANSITIONS AND THERMOPHYSICAL PROPERTIES OF ELECTRICAL CONDUCTORS ABOVE 2000K. Cezairliyan, A. (National Bureau of Standards, Washington, DC). pp 25-32 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The system can measure specific heat, electrical resistivity, total hemispherical emittance, and melting points in subsecond-duration experiments. Temperature measurements are made with a millisecond-resolution photoelectric pyrometer. Experimental quantities are recorded with a high-speed digital data acquisition system. The entire system has a time resolution of approximately 0.4 millisecond. An experiment simulating the conditions of phase transitions is described. Results of measurements on solid–liquid phase transitions in niobium, molybdenum, and tungsten are presented. High-speed measurements of selected thermophysical properties of niobium, molybdenum, tantalum, and tungsten are summarized. Sources of magnitudes of errors are discussed. (FR)

18833 CORRELATIONS AND PREDICTIONS OF THERMODYNAMIC PROPERTIES OF LIQUID METALS AT HIGH TEMPERATURES. Margrave, J. L. (Rice Univ., Houston, TX). pp 71-77 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

An extended effort was made to collect the best available data on the thermodynamic properties of liquid metals, including heats and entropies of fusion, and heat capacities. Attention was concentrated on the heats and entropies of fusion and the heat capacities in a search for parameters that would allow correlation and make possible reasonably reliable predictions for the many high-melting elements yet unstudied—Cr, Hf, Ir, Mn, Os, Re, Rn, Ru, Ta, and W—as well as the hundreds of important refractory compounds and alloys. A mutually consistent table of such liquid-metal properties was assembled, and various correlations are presented graphically. (FR)

18834 ELECTRON MICROSCOPE FOR INVESTIGATION OF METALS AT HIGH TEMPERATURE. Horacsek, O.; Bartha, L. (Research Inst. for Technical Physics, Budapest). pp 97-101 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre National de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The utilization of an emission electron microscope/creep measurement device combination is described. The microscope enables micrographs of incandescent refractory metals to be obtained. At a given temperature, planes presenting different

electron emission work functions have different intensities of emission and thus appear brighter or darker on the fluorescent screen. Many types of process, e.g., structural changes, recrystallization, and the diffusion of impurities, can be observed continuously. Investigations made on tungsten samples are presented. A method is also indicated for the exact determination of the temperature of the part of the sample examined. (FR)

18835 NEUTRON DIFFRACTION AT HIGH TEMPERATURES. Experimental Aspects. Tourand, G.; Breuil, M. (CEN de Saclay Gif-sur-Yvette, France). pp 199-203 of Study of Crystalline Transformations at High Temperatures above 2000K. Paris; Centre National de la Recherche Scientifique (1972). (In French).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

Technological problems have always prevented the extension of neutron-diffraction techniques to high-temperature solid-state studies. A short review is given on neutron spectrometers and the differences between neutron and x-ray diffraction techniques. The usefulness of neutron diffraction for structural studies is discussed, emphasis being given to the low absorbing power of the samples. The Saclay experiment, which enables neutron-diffraction patterns to be obtained at temperatures up to 2,500°K, is described. (FR)

18836 SOLID-PHASE TRANSFORMATION IN HAFNIUM. Barnes, G. (Univ. of Nevada, Reno). pp 327-330 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The solid-phase transition in the metal hafnium was studied by means of field-electron emission techniques. Field-emission patterns are ideal for determining crystal structure in that they give a visible photographable image (single crystal) from which it is readily possible to relate crystal directions within the metal to dark and bright areas of the pattern. The low-temperature form was found to possess a hexagonal crystal structure, as expected, and the high-temperature structure was shown to be bcc. Slides were obtained of several hafnium field emitters exhibiting low and high-temperature structures. Moving pictures of the transitions, going both up and down in temperature were obtained. A sharp boundary could be seen to move across the pattern in going from low to high temperatures, but in lowering the temperature, the transition was sudden, i.e. there appeared to be a hysteresis effect. The transition temperature was found to occur at about 2030°K. (FR)

18837 CHARACTERIZATION AND CONTROL OF THE DESTRUCTIVE CRYSTALLINE TRANSFORMATION IN HAFNIUM OXIDE. Wilder, D. R.; Buckley, J. D.; Stacy, D. W.; Johnstone, J. K. (Univ. of Toledo). pp 335-345 of Study of Crystalline Transformations at High Temperatures Above 2000K. Paris; Centre Nationale de la Recherche Scientifique (1972).

From international colloquium on the study of crystalline transformations at high temperatures above 2000K; Odeillo, France (27 Sep 1971).

The tetragonal–monoclinic crystalline transformation of hafnium oxide can be suppressed by the addition of calcium oxide, magnesium oxide, yttrium oxide, or several of the rare earth oxides. The effects of these additions are considered and tentative phase equilibrium diagrams are given for $HfO_2-Y_2O_3$ and $HfO_2-Er_2O_3$. The principal analytical methods employed are x-ray diffraction techniques and the measurement of thermal anomalies using optical techniques. The most desirable thermomechanical properties were obtained using yttrium oxide as the additive. The nuclear properties of erbium oxide make it a logical choice when hafnium oxide is used for reactor applications. (FR)

18838 MAGNETIC CHARACTERISTICS OF THE METALLO-CERAMIC SOLID ALLOY BK-3M AT LIQUID HELIUM TEMPERATURE. Galkina, O. S.; Lazareva, L. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 14: No. 2, 241-243(1973). (In Russian).

The results of the experimental investigation of the magnetic characteristics of the tungsten carbide–cobalt (BK-3M) alloy at 4.2°K in fields up to 45 kOe are reported. The magnetization, the dependence of the size of the residual magnetization on the external field, and the relation between the residual magnetization and the magnetization in a given field were determined. The hysteresis loop and the dependence of the magnetic permeability on the external field were also determined. (JSR)

18839 CONSEQUENCES OF STATISTICAL FLUCTUATIONS OF URANIUM TEXTURE. Novak, J. (Ustav Jaderneho Vyzkumu, Rez, Czech.). Jad. Energ.; 19: No. 4, 135-136(Apr 1973). (In Czech).

Calculation and theoretical analyses based on parameters and conditions of a uranium nuclear fuel element lattice indicated that statistical variations in the fuel texture are very important. A smaller grain decreases but does not completely eliminate deformation of the uranium core. Jacketed fuel element buckling may be limited by considering these conditions. (TTT)

18840 THERMAL DECOMPOSITION OF $UO_3 \cdot 2H_2O$. Landspersky, H. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 19: No. 6, 203(Jul 1973). (In Czech).

Thermograms of the decomposition of $UO_3 \cdot 2H_2O$, plus evidence from UO_3 hydration studies, indicate that the H_2O is removed in three steps. Thus, this water is not ordinary water of crystallization, where the bond of the water to the base compound is not so strong as here. Experimental data on energies involved are tabulated. (TTT)

18841 RE-ASSESSMENT OF THE MONOTECTOID LOOP (β-Nb + β-Zr) IN THE NIOBIUM–ZIRCONIUM SYSTEM. Flewitt, P. E. J. (Central Electricity Generating Board, Cockfosters, Eng.). J. Appl. Crystallogr.; 5: 423-425(1972).

The shape of the two-phase β-Nb + β-Zr monotectoid loop in the niobium–zirconium phase diagram was reinvestigated by x-ray analysis for alloys with controlled content of interstitial impurities. (auth)

18842 DETERMINATION OF THERMODYNAMIC ACTIVITIES IN THE Cd–In SYSTEM BY CALORIMETRIC MEASUREMENTS. Rosina, A. Mining Met. Quart. (Engl. Transl.); No. 2/3, 85-105 (1971).

A study of the Cd–In phase diagram, using calorimetric techniques, is described. The cooling curves give values for peritectic temperature, eutectoidal decomposition temperature of the intermetallic compound $InCd_3$, and solidus and liquidus temperatures for the In-rich alloys. The activation energies calculated for Cd and In rich alloys at 773°K both show a positive deviation from Raoult's law. (Metals Abstr.)

18843 LEAD AND NICKEL IN Al_3Zr INTERMETALLIC COMPOUND. Podgornik, A.; Ralic, B.; Smolej, A. Mining Met. Quart. (Engl. Transl.); No. 1, 77-79(1971).

An electron microscopical analysis of a typical sample of an Al–5% Zr master alloy is described. The occurrence of the Al_3Zr phase is confirmed and Pb and Ni are shown to be present in this phase. (Metals Abstr.)

18844 HARDENING REFRACTORY METALS BY ROLLING IN A VACUUM. Kovtun, V. I.; Vinitskii, A. G.; Lyashchenko, A. B. Tekhnol. Organ. Proizvod.; No. 6, 37(1971). (In Russian).

The change in surface microhardness as a function of pressure when refractory metals are subjected to dry sliding friction in a vacuum is considered. The pressure microhardness curve does not exhibit a saturation region but passes through a max. (Metals Abstr.)

18845 GRAIN-BOUNDARY MIGRATION AND INTERGRANULAR SLIP IN THE WELD-SEAM METAL OF NICKEL ALLOY JOINTS. Shorshorov, M. Kh. Svar. Proizv.; No. 4, 6-8(Apr 1973). (In Russian).

The effect of the type and concentration of alloying elements on the processes of boundary migration and intergranular slip was investigated in alloys of nickel with aluminum (up to 11 at. %) and niobium (up to 6.55 at. %). Alloying of nickel with Al and especially Nb lowers the slip magnitude. This is related to strengthening of the solid solution, i.e., to the increased shear strength in the grain volume and retardation of dislocation movement. Measurements of microhardness and lattice parameters showed that niobium strengthens the matrix more strongly than aluminum owing to large lattice distortions. Moreover, in the grains of the Ni–Nb solid solution, transverse slip is retarded in connection with the significant lowering of stacking-fault energy. The effect of the type of alloying element on slip was also associated with grain-boundary shape. In Ni–Al alloys the grain boundaries are even and smooth, while in Ni–Nb alloys the Nb promotes formation of complex-shape boundaries with a high degree of evenness which prevent slip. Consequently, alloying of nickel with Nb helps prevent the formation of hot cracks for the reasons given above, while aluminum alloying increases growth of crack formation in relation to increased aluminum content. (JPRS)

18846 COMPLEX CONTINUUM POTENTIAL FOR CHANNELING. Ohtsuki, Y. (Waseda Univ., Tokyo). J. Phys. Soc. Jap.; 34: No. 2, 473-475(Feb 1973).

Complex continuum potentials for channeling due to nonlocal inelastic scatterings are introduced. The relation between the com-

plex continuum potential and the Yoshioka term for electron diffraction is studied. For an example, phonon excitations are considered in detail for numerical calculations of the imaginary continuum potential (absorption coefficient). The local diffusion constant for dechanneling theory is also discussed. (auth)

18847 LUTETIUM. Gschneider, K. A. (Ames Lab., IA). Rev. Chim. Miner.; 10: No. 1, 157-176(1973).

A review is presented on the physical and metallurgical properties of high-purity lutetium. The electronic configuration and the preparation of high-purity metal and single crystals of lutetium are discussed. The physical properties: crystal structure, melting and boiling points, thermodynamic properties, Fermi surface, magnetic susceptibility, electrical resistivity, Hall coefficient, thermoelectric power, thermal expansion, elastic properties, neutron scattering cross section, and hardness are reviewed. The alloying behavior is also briefly discussed. (FR)

18848 NUCLEAR MAGNETIC RESONANCE STUDY OF MONOBERYLLIDES XBe (X = Co, Ni, Cu). Domngang, S. (Univ., Strasbourg). Compt. Rend., Ser. A, B; 276: No. 17, 701-704(25 Apr 1973). (In French).

The spin-lattice relaxation time (T_1) and the Knight shifts of ^{9}Be, ^{59}Co and ^{63}Cu nuclei were measured for XBe (X = Co, Ni or Cu) intermetallic compounds. The T_1T product for ^{9}Be is almost constant for CuBe, varies very little for NiBe, but is highly temperature dependent for CoBe. The Knight shift is positive for copper and cobalt, negative for beryllium in CoBe and NiBe at low temperatures. (FR)

18849 APPLICATION OF AUGER SPECTROSCOPY TO THE STUDY OF SOLID SURFACES AND SOLID-GAS INTERACTIONS. Rovida, G.; Maglietta, M.; Ferroni, E. Vuoto Sci. Technol.; 5: No. 1, 13-23(1972). (In Italian).

The principles of slow electron diffraction (LEED) and the emission of Auger electrons are discussed, and details are given of the application of the techniques to the examination of extreme surface concentration in relation to bulk diffusion and gas/solid reactions. Surfaces studied include Ag, Ag contaminated with Te, polycrystalline Ta, Ag on Au, Cs on Si, and C in three forms CO on W, W_2C, and graphite. (Metals Abstr.)

18850 EFFECT OF HAFNIUM OXIDE ON GRAIN GROWTH AND HARDNESS OF NIOBIUM. Kushtalova, I. P.; Fen, E. K. Tekhnol. Organ. Proizvod.; No. 3, 61-62(1972). (In Russian).

Studies were made of the effects of HfO_2 additions (3.7 and 10.0 vol.%) to Nb on grain growth and hardness. The materials were prepared by (i) compacting powdered mixtures followed by sintering or (ii) by sintering and hot pressing at the same time. The dispersion of the HfO_2 and Nb particles was 0.5 to 3.0 and 13.0 μm, respectively. At 1700 to 2000°C the presence of HfO_2 significantly retards grain growth of Nb, which was lower for the hot-pressed specimens. The maximum effect of the dispersion strengthening was obtained with the minimum particle size of Nb and HfO_2 and was controlled by the interparticle distance. For this the optimum volume concentration of the dispersed inclusions was between 3 and 10%. (Metals Abstr.)

18851 MODE OF DIFFUSION ZONES IN Zr-Cu AND Zr-Nb ALLOY Cu COUPLES. Kimura, H. (National Helth Inst. for Metals, Tokyo); Uehara, S.; Honma, K.; Kimura, T.; Minobe, Y. J. Jap. Inst. Metals; 37: No. 5, 552-557(May 1973). (In Japanese).

The mode of the diffusion zone formed by reaction diffusion by annealing at the vicinity of the $\alpha \rightleftharpoons \beta$ phase transformation temperature and some properties of the intermediate phases were investigated for Zr-Cu and Zr-Nb alloy/Cu couples. $ZrCu_4$ and $ZrCu_3$ were predominantly formed in the intermetallic compounds zone by isothermal annealing and the thickness of each intermediate phase varied with annealing time according to the parabolic rate law. The martensitic zirconium solid solution zone containing about 2% of Cu was formed with a thickness ten times that of the intermetallic compounds zone above the eutectoid temperature of the Zr-Cu system. In the α-Zr temperature range, the zirconium solid solution zone was scarcely formed, and no copper solid solution zone was observed under the present experimental conditions. The shifts of the Kirkendall marker to the Cu side showed that Cu atoms diffuse faster than Zr atoms. In the diffusion couple of Zr-Nb alloy with Cu, the reaction temperature at which a similar degree of the diffusion zone was formed was about 100°C lower than that for the pure Zr-Cu couple. Microhardness (V.H.N.) of the intermediate phases zone were about 750 to 830, and the values are higher than the synthetic compound. In the pickling acid solution of HNO_3 or a mixture of HNO_3 and H_2SO_4, $ZrCu_4$ and $ZrCu_3$ dissolve quickly, but ZrCu, Zr_2Cu, and Zr are almost insoluble. All of the intermetallic compounds in the Zr-Cu system dissolve quickly in the acid mixture of HF. (auth)

18852 INFLUENCE OF PLASTIC PREDEFORMATION ON URANIUM DIFFUSION INTO TUNGSTEN. Yurgens, A. V.; Abdullin, A. G.; Tsvetaev, A. A. pp 221-226 of Fiziko Khimicheskie Problemy Kristallizatsii. Vypusk 2. Alma-Ata, USSR; Kazak Gosudarstvennyi Univ. (1971).

The diffusion of U in predeformed W was studied in polycrystalline W which had been deformed by rolling by 31, 30, 64, and 85%. Diffusion annealing was conducted at two temperature intervals: 1050 to 1200°C, and 1500 to 2000°C. Graphs were constructed which portray the three-dimensional diffusion and boundary diffusion of U in deformed W. Predeformation did not enhance the spatial diffusion rate of U in W, since the diffusion coefficient may be expected to increase in plastically deformed material due to the appearance of extra vacancies. Coefficients of boundary diffusion are in direct proportion to the degree of deformation; with an increase in the degree of deformation, diffusion accelerated. (tr-auth)

18853 ACOUSTICAL METHOD FOR DETERMINING THERMAL DIFFUSIVITY AND RELATIVE DIFFERENCE IN MOLAR HEAT CAPACITIES OF TANTALUM AND VANADIUM. Cannelli, G.; Cannelli, G. B. (Consiglio Nazionale delle Ricerche, Rome). Appl. Phys.; 1: No. 1, 17-25(1973).

An acoustical technique is proposed for determining the thermal diffusivity in solids and the relative difference between the molar heat capacities at constant pressure and at constant volume. The method, which consists essentially of measuring the damping of freely vibrating bars, allows determination of the thermal diffusivity with an accuracy better than ±5% and has the advantage of not requiring a heat source. It also largely eliminates the complications of precise temperature measurements and insulation of specimen holders. Results are given for tantalum and vanadium over the temperature range 60 to 300°K. (8 figures, 22 references) (GE)

18854 COMBINED MAGNETIC AND ELECTRIC HYPERFINE INTERACTIONS OF CADMIUM IN DYSPROSIUM BY TDPAC. Forker, M.; Hammesfahr, A. (Univ., Bonn). Z. Phys.; 260: No. 2, 131-146(1973).

The combined magnetic and electric hyperfine interaction at the site of a ^{111}Cd impurity in magnetically ordered dysprosium was investigated as a function of temperature by time-differential perturbed angular correlation measurements. Three different phases were found in metallic Dy with transition temperatures of 85 and 179°K in agreement with the results of bulk material measurements. In the paramagnetic phase above 179°K, a pure electric quadrupole interaction was observed. The various contributions to the electric field gradient are analyzed and it is shown that the dominant contribution comes from the conduction electrons. In the ferromagnetic phase which extends from 0 to 85°K, the magnetic hyperfine field at the site of ^{111}Cd has the same temperature dependence as the spontaneous magnetization. The value of the hyperfine field at 4.2°K is = (221 ± 4)kG. At 85°K, a transition to the antiferromagnetic phase of Dy occurs, which shows a hysteresis of the transition temperature. In the antiferromagnetic phase, the temperature dependence of the hyperfine field deviates considerably from the magnetization curve. It is suggested that this deviation might be due to a temperature dependence of the s-f exchange interaction. 41 references. (GE)

18855 NUCLEAR MAGNETIC RELAXATION OF TWO SPIN SYSTEMS OF SIMILAR NUCLEI. II. Schneider, H.; Goeldner, R.; Schmiedel, H. (Karl-Marx-Univ., Leipzig). Ann. Phys. (Leipzig); 28: No. 4, 357-362(1973). (In German).

The line shape of the nuclear resonance signal for an AB system is calculated for any ratio of dipole line width, chemical shift, and indirect spin-spin coupling. The splittings obtained correspond, to a large extent, to those calculated under neglect of the line width, while for the amplitude ratio the finite line width produces greater error (by a factor of 2). (2 tables). (tr-auth)

18856 NUCLEAR MAGNETIC RELAXATION OF TWO SPIN SYSTEMS OF SIMILAR NUCLEI. I. Schneider, H.; Schmiedel, H. (Karl-Marx-Univ., Leipzig). Ann. Phys. (Leipzig); 28: No. 4, 346-356(1973). (In German).

A system of equations for the case of two nuclei with spin ½ is given which describes the longitudinal or the transverse components of the nuclear magnetic relaxation owing to the intramolecular dipole-dipole interaction for any correlation time τ_c in comparison to the Larmor period and for any gyromagnetic ratio. With the aid of this system the "½ effect" is discussed and the line shape of the nuclear resonance signal is calculated for the case of similar nuclei. (1 figure) (tr-auth)

18857 REDUCTION KINETICS AND PHASE TRANSFORMATIONS OF TUNGSTEN AND MOLYBDENUM OXIDES. Miroshnichenko, O. Ya.; Smirnov, K. P. pp 113-117 of Termodinamika i kinetika protsessov vosstanovleniia metallov. Moscow; Izdatel'stvo Nauka (1972). (In Russian).

The kinetics of reduction of tungsten trioxide and molybdenum trioxide by hydrogen and carbon monoxide at temperatures from 400 to 850 C were studied. The compositions of the reduction products obtained under various conditions are determined. It is found that the reduction of WO_3 and MoO_3 occurs in steps, leading to the formation of the lower oxides. All the lower oxides of tungsten and molybdenum are formed in the composition range from $MeO_{3.00}$ to $MeO_{2.00}$, where Me stands for either W or Mo. The reduction of $MeO_{2.00}$ to metal occurs in a single stage under all conditions. The reduction of a given lower oxide to the next one occurs in the diffusion range. (IAA)

18858 CHARACTERISTICS OF HETEROGENEOUS REACTIONS IN SYSTEMS INVOLVING SiO_2 AND Al, V, Cr, OR Mo. Ugai, Ya. A.; Kolesnikov, V. G.; Anokhin, V. Z.; Fetisova, S. V. (Voronezh State Univ., USSR). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 2, 156-158(Feb 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 2, 173-175(Feb 1973).

The effect of deposition conditions of Al, V, Cr, and Mo and the subsequent heat treatment of the structures obtained on the potential of plane zones was investigated. The metal was deposited on the oxide surface both in the cold state and heated up to 300°C. The three cases considered were: SiO_2 + M, deposited on a cold oxidized surface; SiO_2 + M, annealed after deposition; and SiO_2 + M, deposited on a hot oxide surface. It is concluded that one of the principal causes of drift of the volt-capacitance characteristics is a change in the composition of the oxidized layer and in the structure of the film itself. It is assumed that the presence of cystalline modifications of SiO_2 and its tendency to form vacant sites in the anionic sublattice, at atmospheric partial pressures of oxygen, affect its chemical activity. (MCW)

18859 SELF-DIFFUSION IN CERIUM. Languille, A. (CEN, Fontenay-aux-Roses, France); Calais, D.; Dariel, M. P.; Coqblin, B. Mem. Sci. Rev. Met.; 70: No. 3, 241-249(Mar 1973). (In French).

From autumn meeting on metallurgy; Paris, France (27 Sep 1971).

An attempt was made to explain the anomalous self-diffusion of bcc ϵ-plutonium in terms of an activated interstitial mechanism (crowdion type). Because of the analogies existing between δ-cerium and ϵ-plutonium, the study of the self-diffusion of δ-cerium was carried out simultaneously in France (Languille) and Israel (Daniel). Agreement between the results is good. The low values obtained for the activation energy and the bcc phase frequency are in close agreement with the expected diffusion mechanism. A crude calculation enables the proportion of activated atoms likely to become inserted in the lattice to be calculated. It is of the order of 1% and is sufficient to interpret the results. The fcc phase diffusion parameters are consistent with a normal vacancy mechanism. (FR)

18860 MAGNETIC SUSCEPTIBILITY OF GALLIUM-INDIUM ALLOYS IN THE LIQUID STATE. Pashaev, B. P.; Seleznev, V. V. (Dagestan State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 134-136(1973). (In Russian).

The temperature dependence of the magnetic susceptibility of pure In, Ga, and their alloys containing 16, 32, 50, 75, and 89 wt. % indium was determined over the range 20 to 420°C. The two metals were diamagnetic in the solid state with susceptibilities of -0.112×10^{-6} (In) and -0.248×10^{-6} (Ga) CGSM/g. Sharp discontinuities were observed at the melting points, particularly for Ga which became paramagnetic in the liquid state. All alloys retained a diamagnetic character. (KSW)

18861 CRYSTALLIZATION OF Fe-Mn-C ALLOYS WITH NIOBIUM. Raskolenko, L. G.; Novomeiskii, Yu. D.; Stasyuk, G. F.; Karmalin, Yu. N.; Gladkov, M. I. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 158-160(1973). (In Russian).

The crystallization of Fe-Mn-C alloys with small additions (0.0, 0.1, 0.3, and 1.1 wt %) of Nb was studied over the temperature range 1100 to 1600°C. The density of this series of alloys was measured as a function of the temperature, and data were obtained on the microstructure of the series. (KSW)

18862 ELECTRON-DIFFRACTION STUDY OF A NONCRYSTALLINE Zr-Ni PHASE. Ray, R.; Szymanski, D. (Northeastern Univ., Boston). Met. Trans.; 4: No. 8, 1785-1790(Aug 1973).

Metastable noncrystalline phases were retained by rapid quenching Zr-Ni alloys from the liquid state over the composition range 25 to 70 at. % Ni. The x-ray and electron-diffraction patterns of the metastable phases showed broad diffraction maxima indicating absence of long-range crystalline order in them. The pair function of the metastable noncrystalline phase in a splat-cooled $Zr_{0.7}Ni_{0.3}$ alloy was determined from the electron-diffraction data. The various interatomic distances corresponding to the positions of the peaks in the pair function curve were determined. The nearest-neighbors coordination number was computed from the area under the first peak. The radius of the first near neighbor shell is 2.95 Å and the ratio of the second to the first interatomic distance is equal to 1.41 that is significantly lower than that observed in most metallic liquids. The local atomic arrangement in the noncrystalline $Zr_{0.7}Ni_{0.3}$ alloy was shown to be based on simple fcc coordination. (2 tables, 5 figures, 35 references) (auth)

18863 MARTENSITIC TRANSFORMATION IN Zr-Ti ALLOYS. Banerjee, S.; Krishnan, R. (Bhabha Atomic Research Centre, Trombay, India). Met. Trans.; 4: No. 8, 1811-1819(Aug 1973).

Martensitic transformation in a series of Zr-Ti alloys was studied by transmission electron microscopy. A transition in morphology and substructure was observed with increasing additions of titanium. The 5 wt % Ti alloy was found to be predominantly dislocated lath martensite while the 10 wt % Ti alloy showed mainly a twinned plate morphology. Twins within the martensite plates could be classified into two categories, namely, thick $\{10\bar{1}1\}$ twins and thin twins mainly on $\{10\bar{1}1\}$ planes and, to a lesser extent, on $\{11\bar{2}2\}$ and $\{11\bar{2}1\}$ planes. In the case of the thick $\{10\bar{1}1\}$ twins, the specific variant of the twin plane was always found to correspond to a plane of the $\{110\}_{bcc}$ type, which is a mirror plane in the parent bcc crystal. When the specific variant of the composition plane was not parallel to a mirror plane, the twins were observed to be very thin. Evidence of slip within individual twin bands pointed to the operation of a multiple shear inhomogeneous deformation. Observations concerning $\{1011\}$ deformation twins due to impingement effect are also discussed. (15 figures, 22 references) (auth)

18864 STRUCTURE AND MECHANICAL PROPERTIES OF INTERNALLY OXIDIZED Ta-8% W-2% Hf (T-111) ALLOY. Liu, C. T.; Inouye, H.; Carpenter, R. W. (Oak Ridge National Lab., TN). Met. Trans.; 4: No. 8, 1839-1850(Aug 1973).

The deformation and fracture behavior of the Ta-8 wt % W-2 wt % Hf (T-111) alloy internally oxidized at 1273°K was studied at test temperatures up to 1589°K (2400°F). The results are discussed in terms of oxygen content, and the morphology of the oxide. Thermodynamic calculations based on lattice parameter measurements indicate that the oxygen solubility in T-111 is low, about 72 ppM at 1973°K. Beyond the solubility limit, oxygen reacts with hafnium to form hafnium oxide, which causes a continuous decrease in lattice parameter until all the hafnium has been removed from the solid solution. A homogeneous dispersion of fine, coherent hafnium-oxygen zones was observed in as-oxidized specimens. These zones coarsened upon annealing at or above 1673°K and eventually precipitated as rectangular HfO_2 particles. Alteration of the oxygen distribution and oxide morphology by heat treatment resulted in large changes in the mechanical properties. For example, specimens aged 15 min at 1973°K showed little change up to 3500 ppM O, but above this level the yield strength increased and ductility decreased abruptly. Ductility was completely lost at 4200 ppM O, independent of test temperature. Specimens with no aging treatment other than oxygen addition lost all ductility at 800 ppM O. The structure and mechanical properties are correlated. (3 tables, 15 figures, 37 references) (auth)

18865 EFFECT OF MOLYBDENUM ON γ' COARSENING AND ON ELEVATED-TEMPERATURE HARDNESS IN SOME EXPERIMENTAL NICKEL-BASE SUPERALLOYS. Biss, V.; Sponseller, L. (Climax Molybdenum Co., Ann Arbor, MI). Met. Trans.; 4: No. 8, 1953-1960(Aug 1973).

The coarsening of γ' and the elevated-temperature hardness have been studied as a function of molybdenum content, time, and temperature in experimental wrought nickel-base superalloys. The alloys were selected from a systematic series containing 3, 4½, and 6 wt % Al and 1 wt % Al plus 3½ wt % Ti. Each of the aluminum (plus titanium) series consisted of four alloys containing 0, 2, 5, and 8 wt % Mo. The alloys were solution-treated plus aged up to 112 h at 1700°F (925°C) and up to 1000 h at 1400°F (760°C). Molybdenum retards the coarsening of γ' on aging; this retarding effect is most pronounced in alloys containing 6 wt % Al. The coarsening of γ' particles follows Ostwald ripening kinetics. Hardness testing in vacuo at temperatures up to 1750°F (955°C) shows that molybdenum also increases the elevated-temperature hardness significantly. The relation of elevated-temperature hardness to the volume fraction of γ' is considered, and the in-

fluence of aluminum and titanium contents is discussed. (11 figures, 31 references) (auth)

18866 MECHANICAL PROPERTIES OF ELECTRON-BEAM-MELTED MOLYBDENUM AND DILUTE Mo–Re ALLOYS. Klopp, W. D.; Witzke, W. R. (Lewis Research Center, Cleveland). Met. Trans.; 4: No. 8, 2006-2008(Aug 1973).

The effects of small rhenium additions on the low-temperature ductility of molybdenum was determined and characterization of the mechanical properties of dilute Mo–Re alloys was observed. Ingots of unalloyed Mo and three Mo–Re alloys were electron-beam-melted from compacted powder-metallurgy electrodes. Low-temperature tensile properties were measured over the temperature range of −195 to 300°C in the worked and annealed conditions. Tensile properties of unalloyed Mo and of three Mo–Re alloys were measured over the temperature range 980 to 1650°C. The creep properties of unalloyed Mo and the alloys were studied at 1315 and 1650°C. It is concluded that high-purity Mo–Re alloys have ductile–brittle transition temperatures considerably lower than those for unalloyed Mo in both bend and tensile tests and in both the recrystallized and worked conditions. Re promotes normal solid-solution strengthening in Mo at elevated temperatures. (MCW)

18867 STRUCTURES AND PROPERTIES OF COBALT-BASE–TaC EUTECTIC ALLOYS. Walter, J. L.; Cline, H. E. (General Electric Co., Schenectady, NY). Met. Trans.; 4: No. 8, 1775-1784(Aug 1973).

A series of cobalt-base alloys with 15 and 20 wt % TaC were directionally solidified to produce a high-temperature composite material. Tensile and stress-rupture properties were determined and related to composition and structure of the ingots. The volume fraction of TaC fibers and the degree of perfection of the composite structure was found to depend primarily upon the amount of chromium in the alloy and, to a lesser extent, upon the amount of TaC in the nominal composition. Tensile and stress-rupture properties of the alloy with the most uniform composite structure exceeded those of any commercial cobalt or nickel base alloy. The elongation to fracture is greater at room temperature than at high temperature because the matrix does not work harden at high temperatures. (5 tables, 21 figures, 9 references) (auth)

Radiation Effects

Refer also to abstracts 18190, 19894, 20285, 20286, and 20298.

18868 (AEC-tr–7451) IRRADIATION OF TUNGSTEN UNDER UNIAXIAL STRESS AT LOW TEMPERATURE. Ponsoye, J. Translated from Radiat. Eff.; 8: 13-26(1971). 25p. Dep. NTIS $3.25.

Measurements were made simultaneously of variations of length and resistivity in tungsten irradiated at 20°K by fission fragments and uniaxially pulled (stress σ). Resistivity changes are completely stress-independent. In particular, neither $(\Delta \cdot \rho)_0$ nor $(\Delta\rho\infty)$ depend on σ. The same behavior applies for $(\Delta \cdot L)_0$. On the other hand, for high irradiation doses, the length change ΔL is a function of σ; ΔL, which tends to a saturation if $\sigma = 0$, increases continuously if $\sigma \neq 0$. The value of $(\Delta \cdot L)_0/(\Delta \cdot \rho)_0$ gives an evaluation of the formation volume of Frenkel pairs: $\nu_{p.F.} = 0.16\ \nu_{at}$. This volume has also been measured in iron ($1.0\ \nu_{at}$) and in molybdenum ($0.6\ \nu_{at}$). It has also been observed that the recovery of radiation defects was enhanced by the presence of the stress. A model is proposed in which most of the defects cluster into dislocation loops. Without an applied stress, the four equivalent Burger's vectors $\frac{1}{2}\langle 111\rangle$ are equally populated: there is an isotropic increase of volume without a change of shape. Under a stress, this four-fold degeneracy is generally raised and then, a change of shape is superimposed to the change of volume: a non saturated length change then takes place. This description, which recalls the phenomenon of growth in anisotropic metals, correctly explains the results and more specifically the constancy of $(\Delta \cdot \rho)_0$ and of $(\Delta \cdot L)_0$ with respect to σ. (auth)

18869 (BNWL-SA-4727) MICROSTRUCTURE OF ION-BOMBARDED SINGLE-CRYSTAL MOLYBDENUM. Brimhall, J. L.; Simonen, E. P. (Battelle Pacific Northwest Labs., Richland, Wash.). 1973. 11p. (CONF-730813-5). Dep. NTIS $3.00.

From conference on defects and defect clusters in bcc metals and their alloys; Gaithersburg, Maryland, USA (14 Aug 1973).

The microstructure produced by bombardment with 7.5-MeV Ta^{3+} ions was studied in zone-refined single crystals of molybdenum at a bombardment temperature of approximately 900°C. Results on polycrystalline molybdenum are also presented. The void concentration reaches a maximum at a relatively low ion dose and further volume changes occur solely by void growth. The resultant void volume swelling shows a less than linear dependence on dose. No indication of swelling saturation is present up to a total dose of 150 dpa. The trend in the data is at least consistent with the approximate swelling formula of Brailsford and Bullough (J. Nucl. Mat., 44: 121 (1972)). The void lattice is well established at a relatively low dose of 10 dpa and increasing dose only produces increased perfection of the lattice. The lattice spacing does not vary with dose. An explanation for the void lattice based on an anisotropy of the vacancy concentration field is suggested. (7 figures, 12 references) (auth)

18870 (CONF-730715–2) TRAPPING OF MOBILE INTERSTITIALS DURING IRRADIATION OF ALKALI HALIDES. Sonder, E. (Oak Ridge National Lab., Tenn.). 1972. 15p. Dep. NTIS $3.00.

Ionizing radiation in alkali halide crystals produces primarily Frenkel defects in the anion sublattice. This was suspected as a result of the analysis of the spin resonance of the H center and was later confirmed by mechanical measurements and by precise x-ray lattice constant measurements. Interstitials are much more mobile than are vacancies. The temperature at which interstitial and vacancy centers become mobile is illustrated and shows that a large range of temperatures for which only one member of the Frenkel pair, the interstitial, is mobile. The study is confined to the temperature range from 50 to 300°K. Conclusions drawn from measurement of interstitial trapping by F-aggregate centers are that the impurity dependence of F-center production at liquid nitrogen temperature is due to trapping of interstitials by these impurities; that the rapid rise of the defect production efficiency with temperature is not related to interstitial trapping, but appears to be due to the variation of interaction potential with separation distance for interstitials and vacancies; and that the defect production efficiency is sufficiently high to be inconsistent with multiple ionization mechanisms for defect production. (MCW)

18871 (CONF-730813–1) HELIUM-ION IRRADIATION OF VANADIUM AND NIOBIUM. Das, S. K.; Kaminsky, M. (Argonne National Lab., Ill.). 1972. 15p. Dep. NTIS.

From conference on defects and defect clusters in b. c. c. metals and their alloys; Gaithersburg, Maryland, USA (14 Aug 1973).

Helium bubble and blister formation in vanadium and niobium by 0.5-MeV helium ion irradiation was investigated for doses ranging from 6.2×10^{16} to 6.2×10^{18} ions/cm^2 and for different target temperatures. The average blister size observed in polycrystalline samples irradiated at room temperature is smaller for the 40% cold-worked vanadium samples than for the annealed ones. This difference in blister size is less pronounced for irradiation at 900°C. The blisters formed on the (111) surface plane of vanadium monocrystals by irradiation at 650 to 750°C with channeled $^4He^+$ ions exhibit distinct crystallographic features similar to those reported earlier for (111) niobium monocrystals. These features can be understood on the basis of certain active slip planes intersecting the (111) surface plane during blister formation. The effects of irradiation temperature on the mechanism of blister formation are discussed. (6 figures, 20 references) (auth)

18872 (CONF-730813–3) IMAGE CONTRAST OF DISLOCATION LOOPS IN bcc METALS. Ohr, S. M. (Oak Ridge National Lab., Tenn.). 1972. 7p. Dep. NTIS $3.00.

From conference on defects and defect clusters in b. c. c. metals and their alloys; Gaithersburg, Maryland, USA (14 Aug 1973).

Electron-microscope image contrast for small dislocation loops in niobium was calculated from the dynamical theory of electron diffraction using the displacement field corresponding to both prismatic and shear components of the Burgers vector. For dynamical diffraction conditions, in addition to the usual black–white contrast, some loops show a triple white–black–white or a black–white–black contrast, depending on the depth and the orientation of the loop. Results indicate that care should be taken in determining the vacancy or interstitial nature of dislocation loops in irradiated bcc metals. (auth)

18873 (CONF-730813–4) TENSILE PROPERTIES OF FAST-REACTOR NEUTRON-IRRADIATED bcc METALS AND ALLOYS. Wiffen, F. W. (Oak Ridge National Lab., Tenn.). 1973. 22p. Dep. NTIS $3.25.

From conference on defects and defect clusters in bcc metals and their alloys; Gaithersburg, Maryland, USA (14 Aug 1973).

Rod tensile samples of Nb, Mo, Ta, one alloy based on each of these metals, and two V-base alloys were irradiated in EBR-II at temperatures between 390 and 1140°C to neutron fluences in the range 1.5 to 6.1×10^{22} neutrons/cm^2 (>0.1 MeV). The effect of neutron irradiation at these fluences and temperatures on the strength and ductility properties was determined in tensile tests

at temperatures between 20 and 800°C at strain rates of 0.02 min^{-1} or slower. The effect of irradiation is most severe in Mo-base systems. Irradiation near 400°C renders Mo–50% Re brittle to at least 800°C. Similar irradiation of Mo and Mo–0.5% Ti produces a high concentration of small dislocation loops in the microstructure and raises the strain-rate-dependent tensile DBTT from below room temperature to the range 400 to 550°C. Brittle failures occur with a mixed cleavage and grain boundary separation fracture mode. Specimens of Ta, T–111, and Nb–1% Zr exhibited zero uniform elongation but had total elongations in the range 4 to 10% with ductile mode fractures for most test conditions. Nb, V–10% Cr, and VANSTAR-7 had 5 to 17% total elongation and uniform elongations in the range 1.5 to 10%. Marked strength increases over control values were found in all samples. The results are discussed in terms of the microstructures and fracture modes. It is concluded that dislocation channeling is the process responsible for the complete loss of uniform elongation where loop hardening predominates. (5 tables, 12 figures, 16 references) (auth)

18874 (CONF-730822-1) SUPPRESSION OF VOID FORMATION IN ZIRCONIUM. Yoo, M. H. (Oak Ridge National Lab., Tenn.). 1973. 29p. Dep. NTIS $3.50.

From symposium on zirconium in nuclear applications; Portland, Oregon, USA (21 Aug 1973).

An analysis is given of the effects of anisotropic thermal expansion coefficients and elastic constants on radiation-induced void formation in Zr and other hexagonal metals. Upper bound values of thermal stress in polycrystalline metals are estimated. A cyclic temperature fluctuation at high irradiation temperature causes changes in internal stresses that suppress nucleation and growth of voids as a result of the enhanced recombination of point defects at grain boundaries and also retard void growth due to the induced self-stress field. Such effects are more pronounced in highly anisotropic Zr than in Mg. Effects of hydrostatic pressure on void formation are also investigated. Other metallurgical variables for void formation are discussed, and an experiment to test the current concept is suggested. (4 tables, 4 figures, 41 references) (auth)

18875 (DP-MS-72-6) IRRADIATION SWELLING AND GROWTH IN URANIUM AND OTHER ANISOTROPIC METALS. McDonell, W. R. (Du Pont de Nemours (E. E.) and Co., Aiken, S. C. Savannah River Lab.). 6 Jun 1972. Contract AT(07-2)-1. 31p. (CONF-720607-35). Dep. NTIS $3.75.

From 10th annual American Nuclear Society conference; Las Vegas, Nevada, USA (18 Jun 1972).

Voids in orthorhombic α-uranium formed by agglomeration of vacancies and manifested as small aligned pores at higher temperatures in the swelling range may serve at lower temperatures as nuclei for growth of large cavities in the metal suffering internal deformations due to anisotropic growth. Void formation in the swelling range is accompanied by condensation of interstitials into dislocation loops with the same orientations on (010) planes that cause anisotropic growth at lower temperatures. The process is thus an "anisotropic swelling" in which the metal elongates in the same dimension as during growth, but internal voids are substituted for the contraction of other dimensions. In accord with this model, increases in dimensions of textured uranium specimens due to growth at low temperature and exposures persist at higher temperature and exposures in the cavitational swelling range, although decreases in other dimensions are reversed as swelling proceeds. Swelling due to void formation in other anisotropic metals has been observed in hexagonal rhenium and magnesium. Alignments of hexagonal-shaped voids on basal planes and interstitial loops on prism planes in rhenium correspond to that expected from the anisotropic growth of the hexagonal metals at lower temperatures. Alignment of both voids and interstitial loops on basal planes in magnesium, however, is an anomalous result of the near-isotropy of thermal expansion coefficients in agreement with observations of no anisotropic growth in the metal. (10 figures, 20 references) (auth)

18876 (DP-MS-73-11) VOID MODEL FOR CAVITATIONAL SWELLING OF URANIUM AND OTHER ANISOTROPIC METALS. McDonell, W. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). [nd]. Contract AT(07-2)-1. 27p. (CONF-730912-1). Dep. NTIS $3.50.

From international conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

Voids formed in uranium undergoing fission, manifested as small aligned pores at 500 to 600°C, may serve at lower temperatures (350 to 500°C) as nuclei for the development of large cavities in the metal under internal stresses due to anisotropic growth. Formation of voids by agglomeration of vacancies is accompanied by agglomeration of interstitials into dislocation loops and associated dislocation structures on the same planes that cause anisotropic growth at temperatures below the cavitational swelling range. The anisotropic swelling that results is an alternative manifestation of the anisotropic growth process, in which the metal elongates during swelling in the same direction as during growth, but internal voids are substituted for the vacancy dislocation loops that cause contraction of other directions. The effect of low-solubility alloying elements in suppressing swelling can be attributed either to trapping of vacancies and interstitials, which promotes their recombination, or to inhibition of the formation and movement of the dislocation loops produced by interstitial condensation. Anisotropic swelling caused by oriented void and interstitial loop formation has been observed in other anisotropic metals, such as hexagonal rhenium and magnesium. In rhenium, the orientation of hexagonal-shaped voids on basal planes and interstitial loops on prism planes produces an anisotropic swelling that corresponds to that expected from anisotropic growth of hexagonal metals at lower temperatures. In magnesium, however, orientation of both voids and interstitial loops on basal planes, a result of the near-isotropy of thermal expansion of magnesium, produces an anisotropic swelling though no anisotropic growth is observed at lower temperatures. (56 references, 2 tables, 12 figures) (auth)

18877 (FRNC-TH-361) STUDY OF VACANCY CLUSTERS IN THE FORM OF VOIDS USING ELECTRON MICROSCOPY: NEUTRON-IRRADIATED NIOBIUM, QUENCHED NICKEL. Fischer, C. (Grenoble Univ. (France)). 1973. 81p. (In French). Dep. NTIS (U. S. Sales Only) $6.25.

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble (France).

The swelling of niobium was studied using transmission electron microscopy. Irradiations were effected at 550 and 600°C using neutrons having energies >=1 MeV and variable flux and doses. Cavities were observed in all the samples. In contrast, samples irradiated at 800, 900 and 1200°C did not exhibit cavities. This behavior is anomalous in relation to the results obtained with other metals. An attempt was made to study the effect of gaseous impurities on the formation of radiation defects. The problem was investigated by studying the effect of quenching nickel samples under high hydrostatic gas (He or Ar) pressures, and the effect of quenching nickel samples into which helium had been implanted. (FR)

18878 (IS-T–581) RECOVERY OF LOW-TEMPERATURE NEUTRON IRRADIATION EFFECTS IN VANADIUM. McIlwain, J. F. (Ames Lab., Iowa). May 1973. Contract W-7405-eng-82. 108p. Dep. NTIS $7.50.

Thesis.

The recovery of oxygen-bearing vanadium between 150 and 500°K after neutron irradiation at 80°K was studied. Vanadium wires containing 250 to 2500 atomic ppM oxygen were irradiated to fast-neutron fluences of 0.35, 1.2, and 2.7×10^{18} n/cm^2 (E > 1 MeV). The recovery of irradiation-induced damage was followed by means of measurements of electrical resistance and low frequency internal friction. To quantitatively measure the concentration of oxygen in solid solution, a specific resistivity was determined with respect to its relaxation strength, which in turn was calibrated by vacuum fusion analysis. Irradiation-induced damage was found to increase with neutron fluence and impurity content. Recovery stages were found in three temperature ranges: below 253°K (range 1), between 253 and 363°K (range 2), and between 363 and 493°K (range 3). An interstitial detrapping process was indicated for range 1, whereas the range 2 mechanism was undetermined. The range 3 recovery, corresponding to 0.2 T_m, was attributed to the migration of oxygen to aggregates of radiation-produced defects in loop or platelet form. (35 figures, 42 references) (auth)

18879 (SLL–73-5266) HELIUM RE-EMISSION AND SURFACE DEFORMATION IN NIOBIUM, VANADIUM, AND MOLYBDENUM. Bauer, W.; Thomas, G. J. (Sandia Labs., Livermore, Calif.). Jun 1973. Contract AT(29-1)-789. 28p. (CONF-730813–6). Dep. NTIS $3.50.

From conference on defects and defect clusters in bcc metals and their alloys; Gaithersburg, Maryland, USA (14 Aug 1973).

Helium re-emission has been measured in niobium, vanadium, and molybdenum during implantation to doses of 4×10^{18} He atoms/cm^2 and at temperatures from 400°C to 1200°C. The resultant surface deformation was observed by scanning electron microscopy, and bulk defects within the implanted layer were observed by transmission microscopy. In general, the He re-emission is low until a critical dose is reached, at which time the re-emission abruptly rises to higher values. Both the critical dose and the re-emission at higher doses are strongly temperature-dependent. In addition, the nature of the surface deformation, gas-bubble

morphology, and defect cluster formation is also strongly temperature-dependent. (9 figures, 16 references) (auth)

18880 MODEL FOR THE EMBRITTLEMENT AND ANNEALING OF IRRADIATED STEEL. De Meester, P. J. (Univ., Louvain, Belgium). Nucl. Technol.; 19: No. 2, 111-116(Aug 1973).

Irradiation of A-302-B steel was performed for fast-neutron fluences up to 10^{21} n/cm^2 (E > 500 keV). Charpy impact and hardness results point to a parallel evolution of these mechanical-property values. On a semilogarithmic graph an increase in slope by a factor of 4 is observed between 3 and 5×10^{19} n/cm^2. At 8.5×10^{20} n/cm^2, increases in the ductile–brittle transition temperature and in hardness were 305°C and 160 kg/mm^2, respectively. Subsequent annealing treatments between 400 and 500°C indicate that major recovery can be attained. An explanation of the embrittlement and recovery evolution, based on the Davidenkov criterion, is developed. (auth)

18881 MODIFIED OROWAN CREEP EQUATIONS FOR A CASE IN WHICH INTERNAL STRESS IS DUE TO BOMBARDMENT WITH ENERGETIC PARTICLES. Gilra, N. K. (Univ. of Roorkee, India). Scr. Met.; 7: No. 7, 797-798(Jul 1973).

A brief redevelopment is presented of the modified Orowan creep equations as given by Gittus (Scr. Met., 6: 481(1972) and Phil. Mag., 25: 345(1972)). (JRD)

18882 NUCLEATION OF VOIDS IN IRRADIATED METALS. III. Impurity Effects. Russell, K. C. (Massachusetts Inst. of Tech., Cambridge). Scr. Met.; 7: No. 7, 755-760(Jul 1973).

The effects of gaseous and nongaseous impurities on the kinetics of void nucleation in irradiated metals were analyzed for the extreme cases where the impurities are essentially immobile compared with the vacancies, and vice versa. The impurities were found to affect the void nucleation rate by changing the free energy of void formation. It was also found that the transition from immobile to mobile behavior occurs over a relatively narrow range of mobilities. (JRD)

18883 SLIP IN COPPER CRYSTALS FOLLOWING WEAK NEUTRON BOMBARDMENT. Essmann, U.; Rapp, M. (Max-Planck Institut fuer Metallforschung, Stuttgart). Acta Met.; 21: No. 9, 1305-1317(Sep 1973).

Copper crystals irradiated with a total dose of 3×10^{16} and 7×10^{16} fast neutrons per cm^2 were deformed in tension at 78 and 4.2°K, respectively. The dislocation arrangement developed after various prestrains was studied by transmission electron microscopy. The dependence of the dislocation density on strain can be explained by taking into account the mutual annihilation of dislocations of opposite sign. A model is proposed which is in agreement with both the observed dislocation densities and the slip-line data reported in the literature. (13 figures, 3 tables, 41 references) (auth)

18884 SWELLING OF NICKEL IRRADIATED BY MEDIUM-ENERGY Ni^+ IONS. Delaplace, J. (CEN, Saclay, France); Azam, N.; Le Naour, L.; Lott, M.; Fiche, C. J. Nucl. Mater.; 47: No. 3, 278-294(Jul 1973). (In French).

After a brief summary of the advantages and drawbacks of bombardment with heavy ions, the experimental apparatus used for studying swelling nickel is described. Problems in the determination of the number of atoms displaced during ion bombardment are discussed. The influence of the following parameters on the swelling of nickel was studied: temperature, gas content, fluence, ion energy. Swelling varied with temperature and increases to a maximum at 620°C for 500-keV nickel ions. Prior helium loading of the samples (10 ppM) reduces swelling and the mean void size and increases the number of cavities. Swelling grows linearly with fluence up to 25 displacements per atom. The number and size of voids grows rapidly in the early stages of irradiation. It is explained how helium reduces swelling and how far the fluences calculated for ion-bombardments need to be corrected to allow valid comparisons with in-pile results is determined. (21 figures) (auth)

18885 VOID FORMATION IN COPPER IRRADIATED BY 500-keV Cu^+ IONS. Glowinski, L. (CEN de Saclay, Gif-sur-Yvette, France); Fiche, C.; Lott, M. J. Nucl. Mater.; 47: No. 3, 295-310 (Jul 1973). (In French).

The formation of voids in thin foils of copper irradiated by 500-keV Cu^+ ions was studied as a function of temperature, irradiation intensity, and dissolved gas content of the samples. A theoretical examination of the phenomena gives a good account of the effects of temperature, the rate of defect creation and the foil thickness, but it fails to account for the fact that at 400°C voids are formed for a dose of 3×10^{-4} dpa/s but not for 3×10^{-3} dpa/s. This is tentatively explained in terms of the influence of the gas content. The effect of gas content on the formation of voids and dislocation loops was moreover demonstrated by degassing thin foils by annealing in ultrahigh vacuum, or by implanting helium before irradiation. (3 tables, 10 figures, 32 references) (auth)

18886 LATTICE LOCATION, HYPERFINE FIELD, AND RADIATION DAMAGE IN Yb-IMPLANTED IRON. Abel, F. (Ecole Normale Superieure, Paris); Bruneaux, M.; Cohen, C.; Bernas, H.; Chaumont, J.; Thome, L. Solid State Commun.; 13: No. 1, 113-116(1 Jul 1973).

The annealing properties of Yb-implanted Fe were studied up to 600°C by the channeling technique and compared to hyperfine-field measurements. Sharp changes in the Yb-aligned scattering yields are found after annealing above 400°C, i.e., in the temperature range where the hyperfine field at the impurity falls to zero. Radiation damage development, particularly in the {100} planes, is shown to explain the results. (auth)

18887 FRICTION CHANGES IN ION-IMPLANTED STEEL. Hartley, N. E. W. (Univ. of Sussex, Brighton, Eng.); Swindlehurst, W. E.; Dearnaley, G.; Turner, J. F. J. Mater. Sci.; 8: No. 6, 900-904(Jun 1973).

From 3rd international conference on ion implantation; Yorktown Heights, New York (11 Dec 1972).

Elements which are known to improve wear performance or to act as solid lubricants were implanted into polished disks of En 352, a case hardening steel which contains several alloying elements to a combined total of about 4 at. %. Precision friction measuring apparatus was used to detect and record the mechanical response of a small tungsten carbide sphere sliding slowly across the surface of the specimen under a known load. Species such as Mo^+, Sn^+, Pb^+, In^+, Ag^+, S^+ and Kr^+ have been implanted; no effect was observed over a Kr^+-implanted zone, but decreases or increases of up to over 40% were observed in the frictional force with the other species, compared with the unimplanted material. The results are discussed. (UK)

18888 IDENTIFICATION OF REACTION PRODUCTS FORMED ON IRRADIATED AUSTENITIC STEEL SURFACES BY ELECTRON PROBE MICROANALYSIS AND γ-RAY SPECTROMETRY. Hilton, D. A.; Robins, I. H. (Central Electricity Generating Board, Berkeley, Eng.). J. Iron Steel Inst. (London); 211: No. 6, 440-443(Jun 1973).

From developments in physical methods of chemical analysis and microanalysis of metals; Zurich, Switzerland (26 Sep 1972).

The 20% Cr–25% Ni–Nb-stabilized austenitic steel which is used as a clad for the uranium dioxide fuel in advanced gas-cooled reactors is subjected to different environments during irradiation. The outer surface of the steel undergoes oxidation due to exposure to the carbon dioxide coolant while, at the surface in contact with the fuel, reaction products are sometimes observed which contain fission products. High-resolution γ-ray spectrometry and electron probe microanalysis are used as complementary techniques to identify the products from these reactions. The γ-ray spectrum provides data on the radioactive nuclides present and is of particular use in identifying fission products, neutron-activated impurities and the non-adherent oxide particles which are released from the outer surface of the steel to the coolant. The results obtained by electron probe microanalysis show the distribution of the constituents in the reaction products, which in conjunction with the γ-ray spectral data, facilitates the interpretation of the mechanisms involved. The relevance of these techniques in relation to an assessment of the performance of the steel is briefly discussed and their importance in identifying areas where further fundamental studies are required is demonstrated. (auth)

18889 STUDYING THE METAL RADIATION DEFECTS FROM THE EMISSION CHARACTERISTICS OF THERMIONIC CURRENT. Rudenko, N. V.; Golovanov, Yu. N.; Abdullin, A. G. pp 206-212 of Fiziko-Khimiceskie Problemy Kristallizatsii. Vypusk. 2. Alma-Ata, USSR; Kazak Gosudarstvennyi Univ. (1971).

Radiation defects in metals were investigated through the thermo-electron current. The circuit diagram of the equipment used is given, and changes in the startup of the electron accelerator were made. Current changes in the polycrystalline tungsten sample were measured between pulses of the beam of bombarding electrons as a function of temperature. Abatement of thermionic emission ceased after 2,000 to 2,500 μsec; with an increase in temperature the thermionic emission increased by a factor of 2 to 2.5 and the drop-off time was reduced to 800 to 1,500 μsec. These and similar observations suggested the possibility of studying a spectrum of radiation defects from high-temperature irradiation and of determining the effect of volume factors on the magnitude of the work function. (tr-auth)

18890 IRRADIATION IN THE ELECTRON MICROSCOPE. Goringe, M. J. (Oxford Univ.). J. Microscop.; 16: No. 2, 169-182(1973).

From colloquium of the French Society of Electron Microscopy; Nantes, France (29 May 1972).

Restricting the range of possible topics to those associated with displacement damage, the review first deals with basic principles of point-defect production and visible damage formation under electron irradiation in the microscope. Subsequent sections illustrate the phenomena observed during the various stages of irradiation and indicate where quantitative measurements and technologically useful deductions may be meaningfully made. (FR)

18891 STRUCTURAL CHANGES IN TUNGSTEN MONOCRYSTAL SURFACES FOLLOWING 2.36-MeV ELECTRON IRRADIATION. Rudenko, N. V.; Chuzhko, R. K.; Abdullin, A. G. pp 213-216 of Fiziko-Khimicheskie Problemy Kristallizatsii. Vypusk. 2. Alma-Ata, USSR; Kazak Gosudarstvennyi Univ. (1971).

The surface that faced the accelerator beam was substantially altered by a dose of 1.3×10^{19} electrons/cm^2. Etched cavities appeared on all surfaces in a uniform density, sharply delineating the subgrain boundaries. This phenomenon was interpreted as the emergence of radiation defects at the grain boundaries. The pits were due to the bombardment of the W surfaces by accelerated electrons. (tr-auth)

18892 REACTIVE ION BOMBARDMENT OF TANTALUM THIN-FILM RESISTORS. Deery, M.; Goh, K. H.; Stephens, K. G.; Wilson, I. H. (Univ. of Surrey, Eng.). Thin Solid Films; 17: No. 1, 59-66(Jul 1973).

Films 400 to 1800 Å thick, composed of a mixture of tantalum and tantalum oxide, were bombarded with 20 to 110-keV argon, oxygen, and nitrogen ions. For all three bombarding ions, the dependence of resistance on dose may be divided into low, medium, and high dose regions. At low doses the resistance drops, probably as a result of desorption of gases, while at high doses the resistance rises rapidly due to complete removal of the film by sputtering. At medium doses the chemical effects of reactive ion bombardment are seen. The oxygen-bombarded specimens show a gradual and continuous rise in resistance, probably as the free tantalum is converted to Ta_2O_5, while the nitrogen-bombarded specimens show peaks in resistance which appear to be associated with the formation of Ta_2N and TaN. The thermal coefficient of resistivity (TCR) was measured for two nitrogen-bombarded specimens and the dose dependence of the TCRs followed that of the resistance, showing a sharp minimum at fairly high doses and resulting in the achievement of the high resistivity of 5000 $\mu\Omega$ cm coupled with a TCR of less than ±100 ppM/°C. (auth)

18893 DETERMINATION OF THE THRESHOLD ENERGIES FOR ATOMIC DISPLACEMENTS IN METALS. Lucasson, P. (CNRS, Orsay, France). J. Microscop.; 16: No. 2, 183-198(1973). (In French).

From colloquium of the French Society of Electron Microscopy; Nantes, France (29 May 1972).

The threshold energies for atomic displacements are important parameters in the theory of radiation damage in crystals. The main methods used for their study are reviewed (polycrystalline and monocrystalline samples). (FR)

18894 ELASTIC MODULI OF INDIAN STEELS AND THEIR VARIATION WITH NEUTRON IRRADIATION. Lakshminarayana, K.; Mallikharjuna Swamy, K.; Sitarama Swamy, P. (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys.; 11: No. 2, 106-108 (Feb 1973).

Elastic moduli for 10 Indian steel specimens were calculated by determining longitudinal and shear velocities, using the critical angle method. It was observed that for specimens having the same carbon content, increase of manganese content results in higher values of Young's modulus and shear modulus, supporting previous results. It was also observed that low carbon content in specimens yields higher values of elastic moduli. The grain size has no effect on elastic moduli. The effect of neutron irradiation on Young's modulus and shear modulus of the specimens is to decrease these values showing a saturation effect at 2.073×10^{12} nvt. (auth)

18895 HIGH POST-IRRADIATION DUCTILITY PROCESS. Chow, J. G. Y. (to United States Atomic Energy Commission). U. S. Patent 3,740,274. 19 Jun 1973. Filed date 20 Apr 1972. 4p.

A method is given for treating certain stainless steels to improve the ductility characteristics after irradiation at high temperatures. The method involves working at room temperatures or lower to a 90% reduction of area followed by low-temperature recrystallization annealing. (Official Gazette)

Other Materials

Refer also to abstracts 17949, 18626, 18688, 18722, 18729, 18752, 18766, 18772, 20599, 20618, 20626, 20635, 20642, 20644, 20652, 20656, and 20661.

18896 (BNL-17978) CONCRETE-POLYMER COMPOSITE MATERIALS AND ITS POTENTIAL FOR CONSTRUCTION, URBAN WASTE UTILIZATION AND NUCLEAR WASTE STORAGE. Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). May 1973. 24p. Dep. NTIS $3.25.

A wide range of concrete-polymer composite materials are under investigation. The old technology of hydraulic cement concrete is combined with the new technology of polymers. Polymer-impregnated precast concrete (PIC) is the more developed of the composites and exhibits the highest degree of strength and durability. Polymer concrete (PC), an aggregate bound with polymer, is potentially a most promising material for cast-in-place applications. PC with solid-waste aggregate holds out interesting possibilities for converting urban waste into valuable construction materials of commerce. PIC and PC also show potential for immobilizing radioactive waste from the nuclear power industry for long-term engineered storage. (7 figures, 10 references) (auth)

18897 (SLA-73-707) EFFECTS OF FILAMENT ORIENTATION AND SPECIMEN THICKNESS ON THE STATIC FRACTURE TOUGHNESS OF CVD/FW CARBON-CARBON COMPOSITES. Guess, T. R. (Sandia Labs., Livermore, Calif.). Jul 1973. 28p. Dep. NTIS $3.50.

The static fracture toughness and failure modes of a filament-wound carbon-carbon composite were determined as a function of filament orientation and specimen thickness. The critical stress intensity K_c and the work-of-fracture γ_f were calculated from the load versus deflection response of single-edge-notched specimens subjected to three-point bending. The magnitude of each toughness parameter decreased with increasing ϕ, the angle between the filament direction and the major axis (long dimension) of the test specimen. K_c was observed to be a linear function of ϕ, whereas γ_f was nonlinear with ϕ. The failure modes were also dependent on ϕ. However, K_c and γ_f appeared to be insensitive to specimen thickness over the thickness range of 0.350 to 0.875 inch. (9 figures, 12 references) (auth)

18898 CHARACTERIZATION OF HIGHLY ORIENTED SYNTHETIC GRAPHITES. Nagle, D. C. University Park, PA; Pennsylvania State Univ. (1972). 122p. University Microfilms Order No. 73-14,029.

Thesis (Ph.D.).

An endeavor has been made to characterize high quality synthetic graphite crystals from two sources: (1) graphite single crystals grown from metal melts of iron and nickel, and (2) heat treated and stress annealed pyrolytic carbons. The mechanisms operative in the growth of single crystals from solution were found to differ substantially with the metal used. Crystals grown using an iron catalyst were nucleated by seed crystals of cementite (Fe_3C), and exhibited extended layer plane growth. In contrast, crystals grown in a nickel matrix developed from spheroids of nickel-carbon solution which segregated from the surrounding liquid. There was no sign of an intermediate carbide phase having been present. The operation of a mechanism of this type is indicative of a condition of high supersaturation. Indeed, the morphology of these crystals indicates such a condition, being much thicker in the c-direction, and less extended in the basal plane than the crystals grown in iron. A series of heat treated pyrolytic carbons have been characterized by x-ray diffraction, diamagnetic susceptibility, density, and oxidation studies. A graph of the diamagnetic susceptibility versus d_{002} spacing exhibited a minimum at 3.37 Å. An explanation of this previously observed effect is given. Oxidation, and preferred orientation studies have indicated that the stress annealing of pyrolytic carbons below 3000°C by a differential thermal expansion technique can produce a material equivalent to commercially produced stress annealed pyrolytic graphite in crystallite size with a somewhat larger mosaic spread. X-ray analysis of pyrolytic materials for preferred orientation has permitted an experimental determination of the Bacon anisotropy factor which may be compared with values obtained using two functions commonly used in the literature for the crystallite distribution. It is found that the $\cos^n\phi$ function more closely approximates the experimentally determined condition. This is borne out by an analysis of magnetic susceptibility of the polycrystalline material. (Diss. Abstr. Int., B)

18899 PHASE CHANGES IN CUBIC RARE EARTH CRYSTALS. Stevens, K. W. H. (Univ. of Nottingham, Eng.); Pytte, E. Solid State Commun.; 13: No. 1, 101-104(1 Jul 1973).

An explanation is offered of the structural transitions and mag-

netic orderings in the cubic rare earth compounds LnX with particular emphasis on the anomalous spin arrangements observed in HoP, DyP and DyAs and in ErSb and ErP. (auth)

18900 PERLITE-POLYMER CONCRETE. Kukacka, L. E. (Brookhaven National Lab., Upton, NY). Konkurito Janaru; 7: No. 7, 28-32(Jul 1973).

A description is given of concrete–polymer composite materials for use as improved materials of construction. Four types are: (a) polymer-impregnated concrete which consists of a precast Portland cement concrete impregnated by a liquid monomer system which is subsequently polymerized in situ by radiation or by thermal-catalytic techniques; (b) polymer–cement concrete consisting of a monomer added to a water–Portland cement aggregate mix which is subsequently polymerized in place; (c) polymer–concrete consisting of an aggregate mixed with a monomer and subsequently polymerized in place; and (d) precast concrete partially impregnated to produce an in-depth polymer coating. For various methods of preparation and polymer content, figures are presented for density, compressive strength, tensile splitting strength, flexure strength, and improvement factor. (UK)

18901 CHANGE OF THE ORIENTATION ANISOTROPY AND MICROPOROSITY IN PYROCARBON. Koizlik, K.; Krautwasser, P.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Atomwirt., Atomtech.; 18: No. 3, 122-123(1973). (In German).

Fragments of pyrocarbon cladding materials were annealed for three hours at temperatures between 1800 and 2800°C. The observed changes in the microporosity and the density confirm the model concept of the orientation anisotropy changes in pyrocarbon due to annealing. The results can be applied to processes involving neutron irradiation. (GE)

18902 CHEMISTRY AND PHYSICS OF CARBON. Volume 6. Walker, P. L. Jr. (ed.). Series of Advances. New York; Marcel Dekker, Inc. (1970). 362p. $25.00

The volume includes the following chapters: Physical Adsorption of Gases and Vapors of Graphitized Carbon Blacks by N. N. Avgul and A. V. Kiselev (271 references); Graphitization of Soft Carbons by Jacques Maire and Jacques Méring (27 references); Surface Complexes on Carbons by B. R. Puri (292 references); and Effects of Reactor Irradiation on the Dynamic Mechanical Behavior of Graphites and Carbons by R. E. Taylor and D. E. Kline. A separate abstract was prepared for the last chapter. (MCW)

For an abstract of an individual chapter see: 18903.

18903 EFFECTS OF REACTOR IRRADIATION ON THE DYNAMIC MECHANICAL BEHAVIOR OF GRAPHITES AND CARBONS. Taylor, R. E. (Purdue Univ., Lafayette, IN); Kline, D. E. pp 283-336 of Chemistry and Physics of Carbon. Vol. 6. Walker, P. L. Jr. (ed.). New York; Marcel Dekker, Inc. (1970).

Procedures and results for the effects of reactor irradiation on the dynamic elastic modulus and internal friction properties of pitch-bonded natural graphite crystals, hot-pressed artificial graphite, artificial graphite, stress-graphitized pyrolytic carbon, and as-deposited pyrolytic carbon are discussed. Effects noted appear to vary largely according to the perfection of the crystallites. In vitreous carbon where the structure is greatly disordered and the crystallites are very small, the modulus changed little when a specimen was irradiated to 1.4×10^{17} nvt (fast) at room temperature. Previous results for as-deposited pyrolytic carbon demonstrated that changes in poorly graphitized carbons tend to be relatively minor. Irradiation doses to 1.8×10^{17} nvt (fast) produced slight changes in the dynamic mechanical properties spectrum of pyrolytic carbon deposited at 2200°C. This included an increase of 5 or 6% in the dynamic modulus at room temperature. Upon testing to 700°K the modulus recovered to approximately as-deposited values. Radiation-induced changes in commercial and reactor graphites, SP-1 graphite, and stress-graphitized pyrolytic carbons are prominent at radiation doses of 10^{17} nvt (fast) or less. It has been shown that reactor radiation effects can be observed in stress-graphitized pyrolytic carbon in the region of 10^{12} nvt (fast). (43 references) (MCW)

18904 CHEMISTRY AND PHYSICS OF CARBON. Volume 7. Walker, P. L. Jr. (ed.). Series of Advances. New York; Marcel Dekker, Inc. (1971). 412p. $29.50.

This volume includes the following chapters: Kinetics and Mechanism of Graphitization by D. B. Fischbach (277 references); Kinetics of Graphitization by A. Pacault (52 references); Electronic Properties of Doped Carbons by Audré Marchand (101 references); Positive and Negative Magnetoresistances in Carbons by P. Delhaes (88 references); and Chemistry of the Pyrolytic Conversion of Organic Compounds to Carbon by E. Fitzer, K. Mueller, and W. Schaeffer. (212 references) (LMT)

18905 CHEMISTRY AND PHYSICS OF CARBON. Volume 8. Walker, P. L. Jr.; Thrower, P. A. (eds.). Series of Advances. New York; Marcel Dekker, Inc. (1973). 328p. $25.50.

The volume includes the following chapters: The Electronic Properties of Graphite (186 references); Surface Properties of Carbon Fibers (100 references); and The Behavior of Fission Products Captured in Graphite by Nuclear Recoil. A separate abstract was prepared for the last chapter. (MCW)

For an abstract of an individual chapter see: 18906.

18906 BEHAVIOR OF FISSION PRODUCTS CAPTURED IN GRAPHITE BY NUCLEAR RECOIL. Yajima, Seishi (Tohoku Univ., Sendai). pp 247-293 of Chemistry and Physics of Carbon. Vol. 8. Walker, P. L. Jr. (ed.). New York; Marcel Dekker, Inc. (1973).

The behavior of gaseous and nongaseous fission products are discussed in the review. The kinetics of the release of xenon and iodine captured in a graphite crystal is discussed. The behavior of xenon release from natural graphite is remarkedly different from that released from artificial graphite indicating that the use of radioactive xenon is an extremely sensitive technique in the determination of graphite perfection, and at the same time the behavior of xenon in graphite crystals is intimately connected with graphite microstructure. The study of the behavior of solid fission products is more difficult than the study of xenon. The thermiochromatographic technique is favorable for the study of the volatile fission products like iodine and tellurium, but does not apply to a study of fission products such as zirconium and niobium, which form stable carbides in the graphite matrix. (47 references) (MCW)

18907 EPR STUDY OF RADIATION-INDUCED CENTERS IN ALKALI-TELLURIDE GLASSES. Mikhailova, T. G. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 114-118(1972). (In Russian).

The paramagnetic resonance spectra in two-component alkali telluride glasses induced by ^{60}Co-emitted gamma radiation was studied. Absorption in the g-factor region 1.93 to 2.05 in all samples studied was independent of the species of alkali cation and the result of two types of paramagnetic centers–α and β. Examination of the dependencies of spectrum parameters on various factors (glass composition, conditions of preparation, etc.) offered a basis for the suggestion that an α center was an oxygen vacancy at the Te–O polyhedral. The β center was associated with oxygen which was not covalently bonded. (tr-auth)

18908 EVALUATING THE THERMAL STABILITY OF GRAPHITES OVER A BROAD TEMPERATURE RANGE. Trapeznikov, D. A.; Anufriev, Yu. P.; Kochetov, D. V.; Laukhina, N. S.; Ursin, V. A. Probl. Prochnosti; No. 9, 18-21(Sep 1972). (In Russian).

Experimental studies are conducted as a basis for analyzing the heat-stressed and limiting states of graphite construction elements and plotting their thermal resistance as a function of temperature. Five grades of graphite were tested: VPP, VPP-1000, MPG-8, ARV, and PROG-2400. Annular specimens were subjected to a load consisting of a steady-state radial heat flux. The temperature was recorded at four points along the radius of the specimen at the time of fracture, and diametric displacements were determined. These figures were then used to calculate the temperature distribution through a cross section of the specimen, as well as tangential strain on the outer surface. The thermal stability of the graphite materials was calculated by determining the temperature differential as a function of surface temperature at the beginning of fracture. An expression is given which approximates the deformed state of the rings within 10%. It is found that the temperature differential and heat flux at fracture are complicated functions of temperature, and that these functions are determined by temperature changes in the principal characteristics of the graphite materials—maximum tensile deformation, coefficient of thermal expansion, modulus of elasticity, and thermal conductivity. (JPRS)

18909 EFFECTS OF THERMAL-NEUTRON IRRADIATION ON AMORPHOUS SILICON FILMS. Adler, D.; Bowen, H. K.; Ferrao, L. P. C.; Marchant, D. D.; Singh, R. N.; Sauvage, J. A. (Massachusetts Inst. of Tech., Cambridge). J. Non-Cryst. Solids; 8-10: 844-849(Jun 1972). (COO-3344-12).

Thin films of vapor-deposited amorphous silicon were subjected to integrated thermal-neutron fluxes up to 8.3×10^{18} n/cm^2. Provided the films had been annealed at 300°C prior to the irradiation, only very small effects on the electrical and optical properties were observed. Results provide evidence in favor of the predominance of thermally activated hopping conduction in the vicinity of the Fermi energy in such films. (auth)

18910 DISTRIBUTION OF POINT DEFECTS IN X-IRRADIATED NaCl CRYSTALS AGED AFTER QUENCHING. Jarosz, B. (Warsaw Technical Univ.). Acta Phys. Pol.; A44: No. 1, 37-43(Jul 1973).

The differences in the concentration of lattice defects in x-irradiated NaCl single crystals aged after quenching, and without thermal treatment, and in as-cleaved crystals were examined. Optical absorption in the 380- to 810-nm range, dielectric losses at 1 kHz in the 50 to 450°C range, and density measurements were performed. It is presumed that the peculiar behavior of the near-surface layer of a quenched crystal revealed by these measurements may be attributed to OH^- ions and vacancy aggregation, which appear in this layer in higher concentrations. (22 references) (auth)

18911 ANISOTROPIES IN THE G FACTOR AND LINE WIDTHS FOR PYROGRAPHITES BETWEEN 300 AND 4.2°K; EFFECT OF NEUTRON IRRADIATION. Carmona, F.; Amiell, J.; Delhaes, P. (CNRS, Pessac, France). Compt. Rend., Ser. A, B; 276: No. 18, 765-768(2 May 1973). (In French).

Electron paramagnetic resonance measurements made on irradiated and nonirradiated pyrographite samples are presented. A qualitative interpretation of the thermal variations, which takes into account the existing number of defects in the samples, is proposed. (FR)

18912 DECHANNELING OF HEAVY PARTICLES BY CRYSTAL DEFECTS. Quere, Y. (CEN, Fontenay-aux-Roses, France). Bull. Soc. Fr. Miner. Crist.; 95: No. 6, 684-689(Nov 1972). (In French).

The channeling of heavy particles is perturbed by crystal defects which, in extreme cases, can even result in dechanneling. This effect can be described by a dechanneling cross section. The effect of radiation defects (small loops), boundaries (grain or twin), stacking faults, and quasi-rectilinear dislocations is discussed. (FR)

18913 STUDY OF RADIATION DEFECTS IN SILICON AND GERMANIUM SINGLE-CRYSTALS AFTER IRRADIATION BY 45 TO 50 MeV ELECTRONS. Eritsyan, G. N.; Melkonyan, R. A.; Saakyan, A. A.; Grigoryan, N. E.; Ayazyan, E. O. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 7: No. 5, 354-360(1972). (In Russian).

The temperature dependence of concentration of carriers and minority carrier lifetime measurements were used before and after irradiation. The thermal stability of the radiation damage was determined from its annealing behavior. The crystal damage caused by electron irradiation is shown to be of cluster type as in the case of neutron irradiation. (auth)

18914 EPR SPECTRA OF RADIATION CENTERS IN THERMALLY TREATED ALKALI TELLURIDE GLASSES. Mikhailova, T. G.; Yudin, V. A. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 116-118(1973). (In Russian).

The EPR spectra of γ-irradiated (sources not specified) alkali metal telluride glasses were investigated after a preliminary thermal processing (340 to 400°C). The spectrum of recrystallized glass was significantly more complex in form and structure. The formation of α and β centers was partially preserved in the crystallization of the alkali telluride glasses, but an entirely new series of structural formations arose, among which were regions analogous to TeO_2. (KSW)

18915 RELEASE PROCESS OF FISSION XENON PRODUCED BY BETA DECAY OF PRECURSOR IODINE IN NATURAL GRAPHITE AT 1,000°C. Fukuda, T.; Omori, S.; Yamagishi, S. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 4, 242-249(Apr 1973).

In order to study the release process of fission xenon produced by decay of the precursor iodine in natural graphite powder, post-irradiation experiments were carried out at 1,000°C soon after 20 min irradiation with UO_2 powder. In an experiment with interruption (2 h heating, 10 day cooling, 10 h heating), it was found that the decay of ^{133}I to ^{133}Xe caused a fraction of the ^{133}Xe produced to be released rapidly, while the remaining fraction was released gradually. This was followed by a continuous heating experiment during which the release rates of ^{133}Xe, ^{135}Xe, and ^{135m}Xe were measured, and in which production and release of xenon occurred simultaneously in a manner similar to conditions prevailing under actual irradiation experiments. The rates of nuclide release were explained by assuming the same release probability for each xenon nuclide as that for ^{133}Xe in the first experiment. The origin of the initial rapid release by decay of iodine to xenon was considered mainly to be the change of chemical interaction between the defects and the atoms trapped therein. The release behavior of xenon after its production was explained by assuming that the activation energies for the release from the defects were lowered by about 10 kcal/mol by the decay. (auth)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

18916 (UCRL-50007-72-3, pp 3-6) SAFEGUARDS: MEASUREMENT OF U AND Pu CONTENT IN DISSOLVED FUEL RODS. Cate, J. L. Jr.; Pickles, W. L. 29 Mar 1973.

In hazards control progress report No. 44.

Progress is reported on the development of a complete x-ray fluorescence analysis system for the measurement of Pu and U in "burned up" power reactor fuel rods. These rods are dissolved in HNO_3 during reprocessing procedures, and the analysis is to be performed on these solutions. The hardware development is nearing completion. Basically, it consists of a small x-ray tube exciter; a sample changer/scatter chamber, with associated collimators, a magnetic beta trap, a special high resolution Si(Li) x-ray detector with its associated electronics, and a computer-based pulse height analyzer. A block diagram of the system is shown. The complete detector-exciter system, with electronics will be assembled in a mobile aluminum framed cart. (TFD)

18917 RANDOM SOURCE INTERROGATION SYSTEM. Foley, J. E. (to United States Atomic Energy Commission). U. S. Patent 3,736,429. 29 May 1973. Filed date 28 Jun 1972. 6p.

A system to assay fissionable material comprising a sample container, a neutron source of americium–lithium, lead shielding, a plastic scintillator neutron detector using fast photomultiplier tubes electrically connected to a coincidence logic system, and rotating the sample by any well known means along with varying the position of the said neutron source is described. (Official Gazette)

Disposal and Storage

Refer also to abstracts 18308, 18896, 20240, 20256, and 20349.

18918 (CONF-730919-1) SITE INVESTIGATIONS FOR A BEDDED SALT PILOT PLANT IN THE PERMIAN BASIN. Lomenick, T. F.; Boch, A. L. (Oak Ridge National Lab., Tenn.). 1973. 26p. Dep. NTIS $3.50.

From symposium on underground waste management and artificial recharge; New Orleans, Louisiana, USA (26 Sep 1973).

High-level radioactive waste contains long-lived nuclides that require complete confinement for long periods of geologic time. Rock salt has long been acclaimed as the preferred geologic medium for the ultimate disposal of these wastes as its unique self-healing properties make it impervious to the intraformational circulation of ground waters. Data have been compiled on the nature and extent of all major salt deposits in the conterminous United States; however, specific site studies have been confined to the Permian Basin and in particular to central Kansas and to a large tract of federally owned land in southeastern New Mexico. A series of core holes have been drilled to provide the critical data for selecting appropriate disposal levels and assessing the hydraulic characteristics of the overlying and underlying formations. Selective portions of the cores have been analyzed to determine the quantities and characteristics of various minerals in the evaporite section and in particular of any hydrated minerals and rocks that could dehydrate upon heating due to radioactive decay of the wastes. Measurements of the physical properties of these rocks have also been made to calculate their deformational behavior. Because of the need for long-term waste confinement, several unique studies have been initiated. The long geologic history of relative quiescence coupled with data on historic earthquakes strongly suggests that the Permian Basin will continue to be tectonically stable for the next few hundreds of thousands of years or for the effective lifetime of the wastes. In addition, studies of subsurface salt dissolutioning show that the rates of basinward migration of the relatively shallow edges of the salt has, during Quaternary time, averaged only a few miles per million years. Also in central Kansas present rates of denudation have been found to average less than a foot per 1000 y while stream incisions in the same area during Quaternary time have not exceeded several hundred feet. Finally, investigations have revealed that the buried wastes would not be adversely affected with the advance of a new continental ice sheet. (auth)

18919 (JAERI-M-5089) RADIOACTIVE WASTE MANAGEMENT IN TOKAI RESEARCH ESTABLISHMENT, JAERI. (Japan Atomic Energy Research Inst., Tokyo). Jan 1973. 33p. (In Japanese). NTIS (U. S. Sales Only).

The construction of the radioactive waste treatment plant in Tokai Research Establishment started in 1958. Radioactive wastes from the Tokai Establishment and other organizations were transferred to the site and were treated during the past 14 years in this plant. In the meantime, many facilities of the plant were replaced or remodeled for improved operation and corrosion protection. The main items were as follows: remodeling and repair of the incinerator; remodeling of the flocculator; replacement of the low-level evaporator; remodeling of the intermediate-level evaporator; and establishment of a new style baling press. Consequently, the present status of the treatment plant has changed from what it was at the early stage. Details of transportation, storage and treatment of the wastes, and also of facilities and treatment methods for liquid or solid wastes at the present plant are described. (auth)

18920 (ORNL-tr-2111) CAN THE RADIOACTIVE WASTES FROM MANY NUCLEAR POWER PLANTS STILL BE KEPT UNDER CONTROL? Holtzem, H.; Schwibach, J. Translated by R. Gregg Mansfield (Oak Ridge National Lab., TN) from Atomwirt., Atomtech.; 13: No. 12, 582-584(Dec 1968). 10p. Dep. NTIS $3.00.

Nuclear power plants have achieved an economic breakthrough. In the case of new power plant projects, in West Germany also, the trend is gradually developing toward the increasingly frequent choice of nuclear energy. Despite this, or perhaps even because of this, various arguments have been presented to us against the use of nuclear energy on a large scale. A series of contributions dealing with these arguments began in the March, 1968 report. In this report the question is discussed as to whether the radioactive wastes from the operation of nuclear power plants can be safely and economically managed if the anticipated great number of large nuclear power plants is realized. (auth)

18921 (SLA-73-575) WASTE HEAT MELT PROGRAM. Hardee, H. C.; Sullivan, W. N. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 23p. Dep. NTIS $3.25.

The integral conduction method is used to study the melt problem which occurs when radioactive waste materials are placed in various cavities in the ground. The geometries of spherical cavities, cylindrical cavities, and disc cavities are considered for an exponentially decaying heat source and a constant heat source. Quantities such as maximum melt radius, melt radius as a function of time, and time to initiate melting are determined as functions of dimensionless melt parameters. (auth)

18922 (TID-3340) RADIOACTIVE WASTE MANAGEMENT. A Bibliography of Publicly Available Literature Pertaining to the USAEC's Hanford, Washington Production Site. (Technical Information Center (AEC), Oak Ridge, Tenn.). Aug 1973. 157p. TIC Free.

This bibliography contains abstracts of 1098 technical reports and journal articles which have appeared in Nuclear Science Abstracts from January 1951 through July 1973 pertaining to radioactive waste management at the Hanford site. (auth)

18923 PREVENTION OF CRITICALITY IN THE STORAGE OF FISSIONABLE MATERIAL. Thomas, W. (Nuklear-Chemie und -Metallurgie, GmbH., Wolfgang, Ger.). Atomwirt., Atomtech.; 18: No. 6, 291-293(1973). (In German).

In addition to such criteria as throughput, capacity, and storage operation which are also valid in conventional storage, the measures necessary to prevent a criticality accident play an important part in the case of nuclear fuels. The most important safety concepts connected with the storage of fissionable materials are described. Since the criticality safety of a storage area has to be covered in a licensing procedure mostly by calculations, the uncertainties occurring in these calculations and the basic assumptions are also described in detail. (GE)

18924 INTERIM STORAGE OF HIGH-LEVEL LIQUID WASTE. Bray, G. R. (Allied-Gulf Nuclear Services, Barnwell, SC). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 8-9(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

Handling Equipment and Procedures

Refer also to abstracts 18173, 18416, and 20265.

18925 (DP-MS-73-27) ESTABLISHING SUBCRITICAL LIMITS. Clark, H. K. (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). [nd]. Contract AT(07-2)-1. 33p. Dep. NTIS $3.75.

Subcritical limits for an operation with fissionable materials may be derived from calculations provided the method is reliable. The draft of a proposed standard prepared by Work Group ANS 8.11 of the ANS Standards Committee for validating calculational methods is presented and discussed. As an example to illustrate the application of the proposed standard, a subcritical limit is derived for the concentration of ^{239}Pu in an aqueous solution. The critical concentration is estimated to be about 7.2 g/l, and a subcritical limit of 7.0 g/l is proposed. (auth)

18926 (RFP-Trans-134) INTERVENTION IN A HIGH-ACTIVITY CELL BY MEANS OF A HEAVY-DUTY REMOTE-CONTROL MANIPULATOR. Calame-Longjean, A. 1965. Translation of IAEA Paper SM-125/15. 13p. Dep. NTIS $3.00.

The series of operations required for the repair, modification and improvement of the chemical engineering equipment of a fission product concentration cell forming part of a complex of hot cells for the processing of irradiated fuels at the Irradiated Fuel Pilot Processing Plant (SAPTCI) at Marcoule, France, is described. Safety was ensured by intensive use and maintenance of remote-control manipulation equipment, which permitted decontamination of the cell and its preparation for entry by maintenance personnel. All the difficulties encountered in this operation are dealt with, and the improvements that would allow financial and personnel savings in its implementation are discussed. (auth)

18927 (RFP-Trans-135) DISMANTLING OF HIGH ACTIVITY CELLS AND DECONTAMINATION OF THEIR EQUIPMENT IN A WORKSHOP. Bourdrez, J.; Marque, Y.; Roger, B.; Bertrand, E.; Peronnet, L. (Commissariat A l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. Translation of IAEA Paper SM 125/18. 6p. Dep. NTIS $3.00.

The high-activity cells at the C. E. N. over the course of years have needed repair and remodeling. Their total or partial dismantling requires particular techniques adapted to the evaluated risks of irradiation and contamination. The general principles observed for the dismantling of the high-activity cells are reported. The methods used to verify some previously drawn conclusions are then reviewed on the basis of specific examples. The installation and methods used in the workshop for receiving and processing a large part of the contaminated materials from the high-activity cells are described. The installations consist principally of a shielded cell designed for pre-decontamination of dismantling of contaminated equipment of large dimensions. There is also a large room adapted for work in protective clothing. The equipment used for the protection and monitoring of the operators are reviewed. The results obtained during ten months of operation are reviewed and evaluated. (tr-auth)

18928 CEGB FACILITIES FOR POST-IRRADIATION EXAMINATION OF CAGR FUEL. Stagg, M. S. (Central Electricity Generating Board, Berkeley, Eng.); Haddrell, V. J.; Elson, A. W. pp 7-10 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Discussion is presented of the design philosophy used in the preparation of the Central Electricity Generating Board's facilities for AGR fuel examination. Modifications to high-activity caves, and the design of equipment for detailed examination of irradiated fuel, are described. A new method is presented for the construction of shielded cells for the preparation and examination of metallographic specimens, using simple prefabricated steel shielding. (auth)

18929 EVOLUTION OF HOT-CELL TECHNIQUES AT RDL, WINDSCALE. Arbon, E. R.; Vaughan, G. A.; Hufton, W. G.; Hind, P.; Bowen, J. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 11-16 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A description is given of the various phases of "in cave" equipment development, the techniques employed, and the factors which influenced either choice or changes of approach over the last 15 years. The techniques and areas of development covered are cutting, measuring, puncturing, and general services. (auth)

18930 RECENT DEVELOPMENTS IN EQUIPMENT FOR VISUAL INSPECTION, PHOTOGRAPHY, AND MICROSCOPIC EXAMINATION OF IRRADIATED PINS. Vallely, J.; Edwards, O. M.; Young, J. W.; Weatherston, J. R.; Skinner, J.; Jepson, M. D. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 17-20 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

Two optical viewing devices used in the nondestructive examination of irradiated fuel pins in concrete shielded facilities at Windscale are briefly described. The first consists of apparatus for taking peripheral photographs of fuel pin surfaces and the second is a viewing device capable of producing high-resolution photographs of fuel pin surfaces at a magnification of ×30. The conversion of a Reichert/Shandon remote control microscope to single face operation and its installation in a new type of lead-shielded cell designed to give access for adjustment, repair, and maintenance, are also described. (auth)

18931 TECHNIQUES EMPLOYED IN EXAMINATION OF IRRADIATED PROTOTYPE FUEL PINS FOR HIGH-TEMPERATURE GAS-COOLED REACTORS. Rich, J. B.; Rose, K. S. B.; Brown, P. E.; Sheldon, B. E.; Evans, J. H.; Keep, R. H.; Venables, J. H.; Williams, D. E.; Campbell, D.; Ritchie, A. B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 21-31 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

The basic HTR fuel pin comprises coated particles of a fissile ceramic pressed with graphite powder to form a cylindrical compact. These compacts are supported on a central graphite tube which is enclosed in an outer tube of graphite. Performance characteristics of importance in the pin design are dimensional stability of all the components, mechanical integrity of the compact and coated particles, and the effect of high-temperature reactor irradiation on physical and mechanical properties of the components, in particular those which can affect the stresses in the pin. The measurement of the distribution of fission products in the irradiated pins is another very important topic, requiring specialized techniques. The post-irradiation examination employs a wide range of techniques, since the performance of all the components, from the complete pin to the individual particle, is of interest. The examination is carried out in concrete caves, lead cells, or glove boxes, depending on the activity level and type of examination required. The equipment used for the various examinations is described and its performance discussed. (auth)

18932 DISASSEMBLING MACHINE FOR IN-CORE THERMIONIC DIODES. Stradal, K. A. (Kernforschungsanlage, Juelich, Ger.). pp 43-44 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

An in-core thermionic reactor (ITR) mainly intended for space application is being developed. It consists of a compact bundle of thermionic diodes or converters surrounded by driver elements and a cylindric reflector, including controls. The emitters of the thermionic converters contain uranium oxide fuel to be heated up, but not enough to keep the reactor critical; for this reason the driving zone is necessary. The emitters work at a maximum temperature of 2000°C and consist of molybdenum. The concentric collectors are kept at 600°C by sodium cooling; they consist of niobium and molybdenum. The converters are very complicated and prototypes are undergoing irradiation experiments. They will have to be disassembled for post-irradiation examination and many precisely located specimens must be taken. A special cutting machine is described. (auth)

18933 PREPARATION OF MAGNOX FUEL ELEMENT COMPONENTS FOR QUANTITATIVE METALLOGRAPHY. Holm, R. A.; Haddrell, V. J.; Hines, G. F. (Central Electricity Generating Board, Berkeley, Eng.). pp 183-187 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

An integrated cave/cell metallographic facility is described in which complete uranium/Magnox fuel elements of activity up to ~10^4 γ MeV curies can be broken down into their component parts and prepared for detailed metallographic examination. Cell and cave usage is maximized by the design of small portable cutting and polishing machines that can be removed remotely. This approach reduces outage time and provides considerable operational flexibility, permitting the facility to be rapidly adapted for examination of other types of fuel element. Problems associated with the sectioning and subsequent metallographic preparation of the hard highly active uranium bar to which a soft Magnox can is intimately bonded are described. The polished samples are etched by either acid attack or an ion bombardment technique specially adapted for remote operation. All results are recorded photographically and a Quantimet (Image Analyzing Computer) is available for assessment of microstructures. (auth)

18934 HOT CELL FABRICATION OF TARGET RODS AND NEUTRON SOURCES. Van Cleve, J. E. Jr.; Williams, L. C. (Oak Ridge National Lab., TN). Weld. J. (N. Y.); 52: No. 8, 497-508(Aug 1973).

One of the more important steps in the successful fabrication of radioisotope containers, known as target rods and neutron sources, is the production of high-quality end-closure welds. The chief problem encountered is that the isotopes contained are highly radioactive, requiring remote manipulation and heavy biological shielding. The Transuranium Processing Plant (TRU) and the High Flux Isotope Reactor (HFIR) have been built at Oak Ridge National Laboratory to provide gram quantities of many of the transuranium elements and milligram quantities of some of the transcalifornium isotopes. The TRU facility is used for process and development work relative to the separation and recovery of transuranium elements. The separation and recovery work is performed in an integrated hot-cell complex which contains three cells for fabrication and inspection of target rods, four cells for the chemical processing, and two cells for high-level chemical analysis. The fabrication procedures for targets and neutron sources is described in which particular emphasis is placed on the remote end-closure welding and inspection techniques. (RCK)

18935 STRAY RADIATION IN REMOTE CONTROL DIAGNOSTIC X-RAY UNITS. Rytila, A.; Ojala, O.; Savolainen, O.; Soila, P. (Univ. Central Hospital, Helsinki). pp 97-99 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The stray radiation field was measured around four different remote control diagnostic x-ray units, and the results are presented and briefly discussed. (WHK)

Transportation

18936 (DPSPU-70-124-4) SAFETY ANALYSIS REPORT UO_2 SHIPPING PACKAGE (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Gates, A. A.; Langhaar, J. W.; Scaggs, R. A. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Jul 1973. Contract AT(07-2)-1. 59p. Dep. NTIS $5.00.

Some 150 Elk River fuel assemblies, containing a mixture of thorium oxide and fully enriched uranium oxide, irradiated to about 25% burnup of the ^{235}U, are to be chemically processed at the ITREC facility in southern Italy. The recovered uranium, as UO_2 powder, is expected to be substantially free of fission products, and to be about 10% ^{233}U, 80% ^{235}U, 10% ^{236}U plus ^{238}U, and 50 parts ^{232}U/mp U, but the product may also contain up to a few percent Th. A lead-shielded container will be used for shipping UO_2 powder from ITREC to ORNL. (TFD)

18937 (STI/PUB-323) REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Safety Series No. 6 (1973 Revised Edition). (International Atomic Energy Agency, Vienna (Austria)). Apr 1973. 157p. IAEA $2.40.

Regulations developed by IAEA on the transport of radioactive materials by all kinds of transporting methods are presented. (TFD)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 18324, 19529, 19830, and 19894.

18938 (ANU-P-572) NOTES ON VACUUM TECHNOLOGY. Ophel, T. R. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 7 May 1973. 72p. Dep. NTIS (U. S. Sales Only) $5.75.

The notes provide a broad overview of vacuum technology and serve as a summary of equipment used in the ANU laboratory auxiliary to the tandem 14 UD beam line system. Headings include definitions and concepts, vacuum pumps, pressure measurement, valves, and vacuum practice. (AT)

18939 POSITRON ACCELERATION USING A 30-MeV ELECTRON LINEAR ACCELERATOR. Saito, T.; Nakada, Y.; Nakada, A. (Tohoku Univ., Sendai). Jap. J. Appl. Phys.; 11: No. 3, 396-403(Mar 1972).

Positron generation at the end of the accelerator, positron acceleration after the positron converter, and also the annihilation photons were studied using a 30-MeV electron linear accelerator. In positron generation, it was found that the thickness of 1.5 to 2.0 mm is most efficient for a tantalum converter in the present energy region. In the case of positron acceleration, the positron energy can be varied from 8 to 22 MeV. A ratio of the positron current within an energy spread of 3% to the total electron current is estimated to be of the order of 10^{-7}. The spectra of the annihilation photons are obtained by a NaI (Tl) crystal spectrometer. (auth)

18940 TYPE EGP-10-1 CHARGE EXCHANGE ELECTROSTATIC ACCELERATOR. Ivanov, A. S.; Kipshin, G. F.; Latmanizov, V. M.; Lysov, A. V.; Mikhailov, V. D.; Roshal, G. Ya.; Subbotkin, S. A. At. Energ. (USSR); 34: No. 5, 401-403(May 1973). (In Russian).

An electrostatic accelerator (Type EGP-10-1) with charge exchange of negative ions at a gaseous target was developed, having the following characteristics: proton beam energy, 3 to 10 MeV; stability of the average energy of the accelerated particles, better than ±5 keV; current of the accelerated proton beam, up to ~3 μA; diameter of the ion beam at the target, not greater than 10 mm. The construction of the charge exchange apparatus and of the cryogenic equipment is illustrated. (KSW)

18941 PROCEEDINGS OF THE 1973 PARTICLE ACCELERATOR CONFERENCE, SAN FRANCISCO, CALIFORNIA, MARCH 5-7, 1973. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 1-1080(Jun 1973). (CONF-730310-).

Separate abstracts were prepared for 220 of the 279 papers presented. The remaining 59 papers were previously abstracted in NSA and may be found in the index under report number CONF-730310-. (WHK)

For abstracts of individual papers see: 18324, 18370, 18943-18979, 18990-19027, 19029-19060, 19062, 19065-19090, 19095-19122, 19127-19152, 19159-19185, 19616, 19794, 20057, and 20176.

18942 LINEAR ELECTRON ACCELERATORS FOR RADIATION FLAW DETECTION. Levin, V. M.; Nikolaev, V. M.; Rumyantsev, V. V.; Tronov, B. N. At. Energ. (USSR); 33: No. 4, 842-844(Oct 1972). (In Russian).

This paper was summarized as paper No. 614/6524 with full copy held by TIC.

The design and application of waveguide linear electron accelerators for radiation flaw detection is discussed. Electron accelerators operating at energies of 4 to 20 MeV are most suitable for the inspection of thick materials of different densities. Further energy increase is, as a rule, undesirable. A comparison of existing linear electron accelerators, betatrons, and microtrons proved that linear accelerators have important advantages in the noted energy interval. (auth)

18943 IMPACT OF ACCELERATORS ON TECHNOLOGY. Morgan, I. L. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 36-39 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Accelerators and accelerator technology have rapidly expanded into Medicine and Industry. The 2500 accelerators in the USA, which represent about ⅔ the worldwide census of accelerators are primarily devoted to practical applications, although the major impact on technology has been produced by a relatively few excellent facilities. Approximately 80% of the current accelerators in the USA are found to be in medical and industrial use representing a capital investment by industry of $200,000,000. Of greater importance is their impact on the treatment of cancer, and the improvement or creation of better products for industrial and consumer use. The development of new accelerators and techniques are required in order to insure continuing benefits to the public. (auth)

18944 SUPPORT OF RESEARCH ON AND WITH ACCELERATORS. Wallenmeyer, W. A. (Atomic Energy Commission, Washington, DC). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 40-43(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Trends in funding of accelerator research in the US are discussed. Particularly, trends in AEC funding of the high-energy physics program are shown graphically. It is seen that the AEC and NSF are responsible for the major portion of accelerator work in the US. (WHK)

18945 PROGRESS ON RF ELECTRON SUPERCONDUCTING ACCELERATORS. Suelzle, L. R. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 44-48(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Superconducting rf electron accelerator prototypes have been operated at Stanford University and at the University of Illinois. Many of the beam performance goals for emittance, current, energy resolution and stability have been achieved. Lower-than-expected accelerating gradients have necessitated the reevaluation of the energy objectives. Recirculation of the electron beam through the superconducting linacs will, however, increase the effective accelerating gradient. (auth)

18946 PROGRESS REPORT ON SUPERCONDUCTING PROTON LINACS. Kuntze, M. (Univ., Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 49-53 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The work on superconducting proton and heavy ion accelerators is reviewed. The helix seems to be an adequate structure for low velocity particles. For energies above 15 MeV/N other types of accelerating structures may be used. Superconducting Nb helices were developed at several places. A maximum gradient of 2.8 MV/m with a Q of $2 \cdot 10^9$ has been obtained recently in Karlsruhe with a $\lambda/2$ Nb helix at 90 MHz. First proton acceleration in superconducting helical structures indicates the status of the new technology. (auth)

18947 EXPERIENCE IN RECIRCULATING ELECTRONS THROUGH SUPERCONDUCTING LINAC. Young, L. M. (Univ. of Illinois, Urbana). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 81-85(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An electron beam of several microamperes has been accelerated by a 6 foot 1.3 GHz superconducting niobium linac to 3.5 MeV on its first pass. It has been returned to the linac for two additional passes with energy gains around 3 MeV per pass to a final energy of 9.5 MeV. The recirculation is accomplished by means of two uniform field magnets placed at each end of the accelerating section in a racetrack microtron geometry which will accommodate the return beams for six passes through the linac. (auth)

18948 3 GHz SUPERCONDUCTING ACCELERATOR CAVITY FOR USE IN AN ELECTRON SYNCHROTRON. Sundelin, R.; Von Borstel, E.; Kirchgessner, J.; Rice, J.; Tigner, M. (Cornell Univ., Ithaca, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 98-100(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Experience has shown that superconducting accelerator cavity performance improves as the operating frequency rises. To use this effect to advantage in an electron synchrotron one must develop cavities of aperture large enough to provide the necessary phase space admittance and of such a configuration as to avoid problems with lost particles and synchrotron radiation in the

orbit plane. The development of such a cavity, open in the mid-plane, is described and test results given. (auth)

18949 VARIABLE ENERGY RACETRACK MICROTRON. Froelich, H. R.; Thompson, A. S.; Edmonds, D. S.; Manca, J. J. (Univ. of Western Ontario, London). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 260-262(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A racetrack microtron whose energy may be varied continuously from 4.5 to 18 MeV has been built at the University of Western Ontario, and has been operated to full energy. Electrons from an external electron gun are injected with an electrostatic inflector, and accelerated in a short sidecoupled linac section. The RF power delivered to the linac section can be varied by means of a power splitter, thus allowing the energy gain in the section to be adjusted continuously from 1.5 to 3 MeV. The accelerator can be operated in three different modes: single traversal of the linac section with a final beam energy of 1.5 to 3 MeV, n = 2 with three traversals of the linac covering the final energy range from 4.5 to 9 MeV and n = 1 with six traversals of the linac and a corresponding energy range of 9 to 18 MeV. The magnetic guide field consists of two 180° magnets with alternating high and low field regions. To satisfy the resonance conditions the average induction can be varied up to 0.6 T and the lengths of the drift space between the magnets can be adjusted by moving the pole pieces of the magnets. (auth)

18950 PROGRESS WITH THE SUPERHILAC. Ghiorso, A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 151-154(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A brief progress report on the SuperHILAC is given. Particular problems with the 3 MV injector and beam monitoring and control are discussed. (WHK)

18951 NATIONAL NUCLEAR STRUCTURE FACILITY FOR BRITAIN. Tait, N. R. S.; Voss, R. G. P. (Daresbury Nuclear Physics Lab., Warrington, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 163-167(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A large electrostatic tandem accelerator has been designed to provide a nuclear structure facility in Britain. The machine is intended to operate initially at a terminal potential of 20 MV, with subsequent upgrading to 30 MV. The design of the facility is described, including the choice of main parameters, the beam optics, column construction, charging system, instrumentation and buildings. An extensive development programme on high voltage problems is being carried out. (auth)

18952 OPERATING RESULTS FROM NAL. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 191-197(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The NAL accelerator achieved design energy of 200 GeV on March 1, 1972. Since that time, the main accelerator has operated as high as 400 GeV and regularly operates at 300 GeV. The highest intensity to date has been 1.8×10^{12} protons per pulse at 300 GeV. This beam has been extracted from the accelerator using a half-integral resonance system to give a slow spill over approximately 250 ms. The extracted beam is presently being split and sent into three different experimental areas. In addition, a target area in the main accelerator enclosure allows experiments to be done on the internal, circulating beam. (auth)

18953 HYDRA ELECTRON BEAM GENERATOR. Martin, T. H. (Sandia Labs., Albuquerque, NM). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 289-293(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The Hydra electron beam generator was designed to simultaneously produce two 1 MV, 0.5 MA, 80 nanosecond electron beams that could be combined to form a single beam. The machine, undergoing final developmental tests, has generated a 0.5 MA, MA, 1 MV peak electron beam from each line. This accelerator consists of a low-inductance Marx generator, two water-dielectric pulse-forming (PF) and impedance-transforming transmission lines and two low-inductance, high-current diodes. A description of the generator is presented along with developmental studies and initial testing data. (auth)

18954 AURORA: AN ELECTRON ACCELERATOR. Bernstein, B.; Smith, I. (Physics International Co., San Leandro, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 294-300(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Aurora was designed to produce a brief, intense radiation pulse, and the electrical specifications derive from the radiation output required. A "test volume" was defined that was roughly a meter cube. It was desired to irradiate this from one side to an average of 50,000 Roentgens throughout. In the laboratory, such yields can only be obtained as the bremsstrahlung from a high intensity electron beam stopped in a high density "converter". To maximize the efficiency of conversion of electron energy into photon energy, the highest possible kinetic energy was selected, consistent with the desire not to produce an excessive quantity of photo-neutrons. The kinetic energy chosen was 15 MeV. Calculations then showed that the dose in the test volume could be achieved with minimum electron energy if the radiation source were a uniformly energized surface about 1.5 m in diameter, placed near one face of the test volume. This source surface is the converter, which must be illuminated by a fairly uniform electron beam. The total charge of 15 MeV electrons needed per pulse was calculated to be about 0.2 Cb. An electron beam pulse duration of 120 ns was chosen to give the desired radiation pulse duration to allow for the finite rise and fall times of the beam pulse. Thus an electron beam specification of 1.6 MA at 15 MeV was arrived at, giving a peak power of 24 terawatts and a total beam energy of almost 3 MJ per pulse. (auth)

18955 FURTHER STUDIES OF COLLECTIVE ACCELERATION OF POSITIVE PARTICLES USING INTENSE ELECTRON BEAMS. Ecker, B. (Physics International Co., San Leandro, CA); Putnam, S.; Drickery, D. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 301-304(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Protons at 12 MeV and nitrogen nuclei (N^{+7}) at 29 MeV were produced during propagation of a pulsed 100 kA, 1 MV electron beam (peak values) through initially neutral hydrogen and nitrogen, respectively. Applied longitudinal magnetic fields of 250 gauss or more severely suppressed proton acceleration; 100 gauss had no effect. Protons having at least 3 MeV were observed 11 cm from the plane of injection of the electron beam into the gas-filled acceleration region. At the time of acceleration, the electron beam current front had already propagated substantially beyond the acceleration region. Use of a colder beam resulted in increased particle energy and in greater sensitivity of proton energy to hydrogen density. The localized pinch model is strongly supported by some of the data and is compatible with all results. (auth)

18956 ION ACCELERATION IN ELECTRON BEAMS. Kuswa, G. W.; Bradley, L. P.; Yonas, G. (Sandia Labs., Albuquerque, NM). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 305-309(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Collective ion acceleration has been proposed and studied by investigators in plasma and vacuum diodes and in low pressure neutral gases. It has only recently been noted that similar features exist for intense discharges across initially vacuum or plasma filled gaps and for intense electron beams drifting in initially neutral gases. In all these devices, energetic ions have been found to be radially and axially emitted, and rapid current changes often associated with radiation and particle emission have been seen. A more thorough understanding of the physics involved is certain to elucidate the processes responsible for neutron production in various pellet and wire heating experiments. Some analogies between these experiments and investigations of linear pinches, exploding wires, and plasma focus devices are pointed out. At the present level of understanding, the collective process of acceleration is not useful for producing a high quality accelerator, but as more is learned it may be possible to control the process. (auth)

18957 STATUS REPORT ON THE UNIVERSITY OF MARYLAND ELECTRON RING ACCELERATOR PROJECT. Reiser, M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 310-314(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The final concept, engineering design, and present status of the University of Maryland ERA Project is reviewed. A hollow cylindrical electron beam is produced by an injector which was designed by W. Lupton and coworkers of the Naval Research Laboratory in collaboration with members of the Maryland ERA group (design values: maximum energy 5 MeV, peak current

20 kA, pulse width 20 ns). The hollow beam is compressed into a short ring via transmission through a cusped static magnetic field configuration. The laboratory housing the facility was ready in June, 1972, construction of the injector was completed in September. Testing of the injector and assembly of the cusp and compressor coil system began in October. A first electron beam was obtained on February 22. The main results of injector, diode, and magnetic field measurements are presented. Some problems and solutions are discussed and the methods for gas loading and ring trapping are described. (auth)

18958 NEW GARCHING FAST ERA EXPERIMENT. Andelfinger, C.; Herrmann, W.; Jacobi, D.; Luccio, A. U.; Ott, W.; Schumacher, U.; Ulrich, M. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 276-279(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A single-turn coil for fast electron ring compression and magnetic expansion acceleration was built. It combines a fast magnetic field rise [(dBz/dt)/injection = 3×10^9 G/s] for very fast resonance crossing (within less than 100 ns) with a smooth and weak expansion field [$B_r = 5$ G, (dBr/dr) spill out < 0.5 G/cm]. The first experiments showed strong collective behavior of the electron ring at particle numbers of $N_e = 5 \times 10^{12}$, mainly radial collective oscillations with the frequency $(1 - \nu_r)\,\omega_0$, which could be suppressed by increasing the corresponding Landau damping coefficient. (auth)

18959 ERA RESEARCH IN JAPAN. Kawaski, S.; Miyahara, A.; Huke, K.; Ishizuka, H.; Horikoshi, G.; Saad, H. M.; Kubota, Y. (Nagoya Univ., Japan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 280-282(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An overall view of the ERA research plan in Japan is given. The system has a field emission electron gun producing several kA driven by a Marx and a Blumlein during some tens of nsec and a large vacuum chamber made of stainless steel into which the electron beam is injected and captured. The coils for compression are placed inside the chamber and produce a fast rising magnetic field. The electron ring has a final radius of about 2 cm and the energy of electrons should be about 10 MeV. Special attention is given to the theoretical and the experimental studies of the collective phenomena related to the ring stability just after the injection, the possibility and the efficiency of the acceleration of a charged bunch with an RF cavity, and other problems of the instabilities that may arise. (auth)

18960 RECENT EXPERIMENTS ON ERA IN KARLSRUHE. Dustmann, C. H.; Krauthg, H.; Steinbock, L.; Zernial, W. (Univ., Karlsruhe, Ger.); NS-20: No. 3, 283-285(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The experiments on ERA in Karlsruhe are reviewed. A new compression coil system including devices for roll out, spill out and expansion acceleration is under construction. Two possible applications of a molecular beam source for heavy ion and cluster ion acceleration are proposed. (auth)

18961 STATUS REPORT OF THE LNPI 1 GeV SYNCHRO-CYCLOTRON. Chernov, N. N. (Inst. of Nuclear Physics, Leningrad). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 263-265(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The main parameters of the 1-GeV synchrocyclotron, which began operation in April, 1970, are given. (WHK)

18962 SOME EFFECTS AT HIGH INTENSITIES AT THE 76-GeV PROTON SYNCHROTRON. Ado, Y. M.; Myae, E. A.; Troyanov, E. F. (Inst. for High Energy Physics, Serpukhov, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 266-267(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Some peculiarities of the 76-GeV accelerator operation at intensities up to 2.5×10^{12} protons/pulse are being reported. Possible causes for increase of particle losses with beam intensity are discussed; also, data on correction of some betatron oscillation resonances are presented. (auth)

18963 CONSTRUCTION DETAILS OF THE TRIUMF H^- CYCLOTRON. Burgerjon, J. J. (Univ. of British Columbia, Vancouver); Fredriksson, O. K.; Otter, A. J.; Grundman, W. A.; Stonehill, B. C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 243-247(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The TRIUMF cyclotron includes seven major components requiring large industrial contracts: the magnet cores, coils, dc power supply, vacuum chamber, support structure, rf resonators and rf power supply. The first five components are discussed, together with actual performance data. The rf components have been described recently and will be installed in the cyclotron in about two months. The costs of these components plus associated building, engineering and inspection fees are given. (auth)

18964 EXPERIMENTAL RESULTS FROM THE TRIUMF CENTRAL REGION CYCLOTRON. Blackmore, E. W.; Dutto, G.; Joho, W.; Mackenzie, G. H.; Root, L.; Zach, M. (Univ. of British Columbia, Vancouver). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 248-249(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The beam performance obtained up to now in the TRIUMF central region cyclotron is described. A stable beam of 12 μA H^- ions has been obtained at the full radius of 30 in. out of a dc beam of 100 μA given by the ion source. 90% of the beam injected into a 30° phase interval has been kept within a vertical distance of ±0.4 in. from the geometric midplane during acceleration, and the radial turn positions measured along three azimuths agree to within ±0.15 in. with the theoretical "centered beam positions" for all phases between 0° and 30°. (auth)

18965 PROGRAM USED TO RETUNE THE ZERO GRADIENT SYNCHROTRON (ZGS) AFTER THE INSTALLATION OF A NEW VACUUM CHAMBER AND POLE FACE WINDINGS. Kustom, R. L. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 253-256(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

During the summer of 1972, the ZGS main ring magnets were completely dismantled and a new vacuum chamber was installed. The adjusting parameters and retuning program are outlined. Magnet adjustments, injection matching, damper adjustments, and results of the retuning program are discussed. (WHK)

18966 224 cm VARIABLE ENERGY CYCLOTRON AT CALCUTTA. Ambasankaran, C. (Bhabha Atomic Research Centre, Bombay); Phadke, D. Y. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 236-239(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Progress of work on the construction of the 224 cm Variable Energy Cyclotron being installed at Calcutta is described. The cyclotron, with maximum expected energies of 70 MeV protons, 65 MeV deuterons and 130 MeV alphas, follows the design of the 88" cyclotrons at the Lawrence Berkeley Laboratory and the Texas A & M University, with some modifications incorporated for facilitating indigenous fabrication and for improved performance. The yokes and yoke legs of the 250 tonne magnet have been cast and tested for composition and porosity. The machining of yokes, yoke legs and pole pieces is under way. The main coil winding has started. The trim and valley coils will be epoxy potted. The rf system, utilizing the RCA 6949 oscillator tube, is a combination of a self-excited and a driven system. Power supply fabrication is nearing completion and two 89 cm diffusion pumps have been fabricated for the vacuum system. The building is in the final stages. Beam transport layout envisages three high intensity and six high resolution channels. A small 8k on-line computer is being planned. Various other facilities are also being planned. (auth)

18967 RECENT PROGRESS IN THE PERFORMANCE OF THE DESY-ELECTRON SYNCHROTRON. Kumpfert, H. (DESY, Hamburg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 231-235(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

During the first years of operation, primary emphasis was put on achieving reliability and stability. Of special note is the improvement in the slow extracted electron beams. More recently, installation of a "flat top" giving us an improvement of duty cycle from 4.5% to 15.4% ($\Delta E/E = \pm 0.25\%$) has motivated us to emphasize increase of beam intensity. Intensity dependent instabilities have been encountered, studied, and to some extent cured. (auth)

18968 PRESENT STATUS OF THE 590 MeV RING CYCLOTRON OF SIN. Willax, H. A. (Swiss Inst. for Nuclear Research, Villigen, Switzerland). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 202-206(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A 590 MeV ring cyclotron, using a 72 MeV cyclotron injector (Philips design), for a cw proton beam of 100 μA at 50 MHz is under construction at the Swiss Institute for Nuclear Research (SIN), near Villigen, Switzerland. While the mechanical assembly approaches completion, tests of sub-sections of the machine are being carried out. A $\frac{1}{4}$ ring section, containing internal elements, was investigated under operating conditions. Results are presented and discussed. (auth)

18969 PROBLEMS AND POSSIBLE SOLUTIONS FOR THE TRIUMF PROJECT. Richardson, J. R. (Univ. of British Columbia, Vancouver). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 207-212(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Some of the design problems peculiar to TRIUMF are discussed. These problems arise from the large size of the magnet (4000 tons) and low average magnetic field which in turn are required by the necessity of avoiding electric stripping of the H^- ions. Gas stripping of the ions requires the low operating pressure of 4×10^{-8} torr. Problems arising from the acceleration on the 5th harmonic of the ion frequency and their relation to the unusually tight tolerances on the position of the accelerating electrodes are discussed. Some preliminary results of the magnetic field measurements are presented. (auth)

18970 ACCELERATION OF POLARIZED PROTONS IN THE ZERO GRADIENT SYNCHROTRON (ZGS). Ratner, L. G.; Khoe, T. K. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 217-220(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Those factors which make the ZGS an excellent accelerator for minimizing the depolarization of an accelerating beam of polarized protons are explained. (WHK)

18971 COLLECTIVE ACCELERATION OF INTENSE ION BEAMS IN VACUUM. Luce, J. S.; Sahlin, H. L.; Crites, T. R. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 336-341(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A diode system with an insulated anode and rear target that operates in vacuum and produces 4×10^{10} neutrons per pulse was developed. The system forms a pinch discharge that ejects a cluster of collectively accelerated ions that attain full energy in 7 cm. Target neutron data and activation analysis with multiple foils show that pulses of 10^{14} protons with energy up to 15 MeV have been achieved. Experiments with electrode materials and diode geometry have lead to large improvements in focusing and ion beams have been propagated 8 ft in vacuum. The presence of high-energy carbon ions indicates that the pinch has the capability of forming and accelerating multiple ionized high-Z ions. (auth)

18972 TWIN-TANK ACCELERATOR FOR HIGH-VOLTAGE ELECTRON MICROSCOPY (HVEM). Reinhold, G.; Gleyvod, R. (Emile Haefely and Co. Ltd., Basel). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 378-382(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

HVEM has become a useful method of research in metallurgy and biology. It was necessary to develop special electron accelerators for the supply of these high-voltage microscopes. In view of ac interference problems with air-insulated accelerators, a commercial 1 MV twin-tank accelerator was introduced in 1967. The voltage in this basic model was extended to 1.5 MV and stability improved from $\pm 1 \times 10^{-5}$ to $\pm 1 \times 10^{-6}$. The future requirements of the electron microscopists, which are directed towards even higher accelerating voltages and greater stability, can also be met by the principles of the symmetrical cascade generator and twin-tank accelerator. (auth)

18973 UNIVERSITY OF ROCHESTER TANDEM UPGRADING. Purser, K. H. (Univ. of Rochester, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 383-386(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A major upgrading program for the HVEC MP tandem accelerator for operation above 10 MV is described. Modifications to the accelerator tube geometry, to the electrostatic structure of the terminal and support column, to the resistor divider chains of the machine, and to the vacuum system to allow terminal pumping are described. (WDK)

18974 SLAC RECIRCULATING LINEAR ACCELERATOR. Herrmannsfeldt, W. B. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 910-913(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Encouraged by the productivity of the physics results from SLAC, and seeking a more immediate plan to increase the energy capability of the accelerator, the laboratory last year proposed to construct a Recirculating Linear Accelerator. This device, which would double the peak energy of the accelerator, was estimated to cost about $18 million and take 2$\frac{1}{2}$ years to construct. A Task Force was created under the leadership of John Rees to further develop the plans for the project in anticipation of federal authorization in Fiscal Year 1974. The RLA was not included in the Federal Budget for FY '74, but the laboratory plans to resubmit the proposal for FY '75. Studies on the RLA are continuing and the current status of these studies are presented. (WHK)

18975 INITIAL OPERATION OF THE MIT ELECTRON LINEAR ACCELERATOR. Haimson, J. (Haimson Research Co., Burlington, MA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 914-918(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Initial operating experience with the various high power subsystems is discussed, and the results of electron beam tests at progressive stages of completion of the linac are presented. A highly stable analyzed beam containing greater than 85% of the accelerated current has been demonstrated routinely using ±0.11% analyzing slits at both the 20 MeV and 120 MeV stations. Of particular importance, especially for beam transportation and future considerations of beam recirculation, has been the achievement of an extremely low emittance. Beam measurements at the 20 MeV station have confirmed that essentially all of the accelerated current is contained within an emittance of $7 \pm 2 \times 10^{-4}$ $\pi m_0 c$-cm; i.e., ~0.2 mm mrad at 20 MeV. System checkout is currently in progress to bring the linac up to its maximum operating condition of 430 MeV at a duty factor of 1.8%. (auth)

18976 100% DUTY FACTOR ELECTRON LINAC. Baglin, J. E. E.; Bureau, A. J.; Cook, B. C.; Holland, G. E.; Morrison, R. C. (Ames Lab., IA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 932-933(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An electron linac has been designed and specified. It uses three currently available 200 kW CW klystrons and standing wave 805 MHz cavities of LAMPF design, operating with manageable heat dissipation of 0.5 kW per cavity. Beam characteristics include: beam energy (max.): 40 MeV (duty factor 50%), ≤30 MeV (duty factor 100%); mean beam power: 160 kW at 30 MeV, CW; short-pulse mode: 160 kW at 2×10^5 pps, 10 ns; fast neutron flux (short-pulsed): 5×10^{14}/second; and monochromated photon flux: 2×10^8/second (50 keV resol.). At energies above 30 MeV, in order not to exceed power dissipation constraints, duty factor must be reduced. The continuous beam gives the machine outstanding capacity to service a tagged photon monochromator, and a high intensity, high PRF pulsed source of fast neutrons. (auth)

18977 RECENT DEVELOPMENTS AND PROJECTS AT THE SACLAY'S 600 MeV ELECTRON LINAC. Aune, B.; Jullard, M.; Netter, F. (CEN de Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 934-937 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

High power runs (>150 kW average in the beam) and very high resolution beam handling ($\Delta E/E = 10^{-4}$) are described. A new assembly for producing high intensity positrons is tested. A new standing wave section for the first acceleration of the positrons is under construction. A pulsed magnet giving alternately beams in two rooms with 10 ms switching time is under completion. Studies now under way include improvements of the beam emittance, increase of the maximum duty cycle (25 μs at 1000 Hz instead of 10 μs at 2000 Hz), automatization of some functions in the beam handling systems and in the linac itself, more generalized alternate beam switching and also division of the linac in a low energy part (200 MeV e^- or 100 MeV e^+) and a high energy part (400 MeV e^-) operating simultaneously with a second injector located at the low energy station. Projects under investigations are trying to use separately two simultaneous beams at different energies coming from two injectors or from the selection of some 3 GHz bunches by a section operating at 1 GHz. The transformation of the linac in a superconductive one (10 MV m) is also considered for the future. (auth)

18978 MULTI-ORBIT RECIRCULATION SYSTEM FOR A SUPERCONDUCTING LINEAR ACCELERATOR: THE RECYCLOTRON. Rand, R. E. (Stanford Univ., CA). IEEE (Inst. Elec.

Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 938-942(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The energy available from a superconducting linear electron accelerator (SCA) may be increased many times by means of an economical multi-orbit recirculation system, which preserves the most desirable characteristics of the SCA: good energy resolution ($\sim 10^{-4}$), high current and unity duty cycle. Furthermore, these properties of the SCA and its excellent emittance considerably simplify the design of the transport system and minimize aperture requirements. In order to maintain energy resolution each orbit of the recirculation system must be isochronous with respect to all phase space variables and beams must be reinjected into the linac precisely at the correct phase. These conditions have been achieved in a compact separated orbit design which uses multichannel uniform field bending magnets. It is suggested that such a device be called a recyclotron. At HEPL a prototype 4 orbit recirculation system is being planned as part of the SCA program. Cost estimates for machines of this type have been made and show considerable advantage over other types of accelerator, especially at very high energies. The configuration also shows promise as an intermediate energy, high current accelerator, which could provide a source for a medical pion therapy facility. (auth)

18979 HIGH ENERGY PHYSICS HORIZONS. Panofsky, W. K. H. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 1045-1049(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A discussion on the present status and outlook for high-energy accelerator development and elementary particle research is given. (WHK)

Auxiliaries and Components

Refer also to abstracts 19149 and 19794.

18980 (ANL-Trans-944) PONDEROMOTIVE STABILITY OF rf RESONATORS AND RESONATOR CONTROL SYSTEMS. Schulze, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Nov 1972. Translation of KFK-1493. 181p. Dep. NTIS $11.25.

Linear and nonlinear stability conditions for an rf-cavity exposed to large ponderomotive (electromagnetic) forces are derived and discussed. Stabilization techniques using amplitude and phase control loops are investigated. It is shown, that ponderomotive stability can be insured by proper choice of control parameters. Under certain conditions ponderomotive forces can damp mechanical oscillations induced by external sources. The calculated stability thresholds, the effectiveness of stabilizing and the damping property of the electromagnetic field were confirmed experimentally. These experiments were carried out with a superconducting helically loaded resonator within construction of a superconducting proton linear accelerator at Karlsruhe. (auth)

18981 (CEA-CONF-2263) USE OF MAKROLON AS INSULATING MATERIAL, IN HIGH VOLTAGE TECHNOLOGY. Bernard, P.; Bony J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 7 Mar 1972. 9p. (CONF-720350-1). Dep. NTIS (U. S. Sales Only) $3.00.

From international symposium on high voltage technology; Munich, F. R. Germany (9 Mar 1972).

The properties and use of makrolon (a polycarbonate) in the insulating cantilever-girders of the 750-keV pressurized preinjector for the Saturne Synchrotron are described. Problems of moisture absorption and drying processes by pumping at 10^{-2} torr and by baking are discussed. (WHK)

18982 (LA-UR-73-965) EFFECTS OF LOAD MISMATCH ON THE HIGH-POWER MULTICAVITY KLYSTRON. Tallerico, P. J. (Los Alamos Scientific Lab., N. Mex.). [nd]. 10p. (CONF-730913-1). Dep. NTIS $3.00.

From European microwave conference; Brussels, Belgium (4 Sep 1973).

Each of the forty-four klystrons at the Los Alamos Scientific Laboratory, Clinton P. Anderson Meson Physics Facility (LAMPF), is capable of providing more than 1¼ MW of peak rf power at 805 MHz into the standing-wave linac. The cavity fields in the accelerator must be controlled to ±1% in amplitude and ±1° in phase for optimum performance of the accelerator. These field tolerances must be maintained for any VSWR ≤ 1.5:1. This mismatch is due to thermal detuning and beam loading in the accelerator. This study of the interaction between the klystron and an accelerator section was undertaken to determine how the klystron design parameters affect the controllability, stability and efficiency of the system. The klystron output gap interaction and the output circuit were studied in detail. The output gap analysis yields a valuable insight about the klystron power transfer curves under matched and mismatched conditions. A large-signal model of the electronic interaction in the output gap is derived and numerical results are used to predict the klystron power transfer curves. Although the goal of accurately predicting the Rieke diagram of a klystron has not yet been obtained, quantitative agreement between the numerical and experimental results was achieved. (auth)

18983 (ORNL-tr-2670) PROPAGATION OF RADIATION THROUGH LABYRINTHS OF THE 70-GeV SYNCHROTRON. Borodin, V. E.; Obryashikova, L. P.; Chimankov, M. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. Translation of IFVE-ORE-71-84. 8p. Dep. NTIS $3.00.

The radiation field distribution in two typical multichannel labyrinths of different cross-sections and shape passing through the biological shielding of the 70 GeV synchrotron and used for technological purposes were studied, and the results are given. (auth)

18984 (TID-26370) OPERATION MANUAL FOR PROGRAM "NUWIE". Concaildi, G. A. (Argonne National Lab., Ill.). 17 Apr 1973. 8p. Dep. NTIS $3.00.

NUWIE is an interactive beam optics program, designed to determine the emittance of high energy beams. By measuring the size conditions at different locations in the beam line and for different quadrupole settings, the emittance can be theoretically calculated. As many as 15 different beam lines may be described, with a maximum of 6 conditions per system. However, due to limitations of the CDC-924A memory, a true maximum of 75 conditions is the upper limit when a large number of beam lines are described. These beam lines need not be identical in their description. NUWIE eases the burden of describing the beam lines to be used by allowing the user the use predefined MAYPO data-sets as a common data base. By modification of these data-sets and by storing them with unique names, the user can pick the desired combination of data-sets for his calculations. Emittance calculation is not the only capability of NUWIE. If the beam positions are measured at different locations and for different quadrupole settings, the best starting ray describing the beam may be calculated. However, emittance and ray calculations cannot be made simultaneously. (auth)

18985 NEW ACCELERATING TUBE FOR 4 MV VAN de GRAAFF ACCELERATORS. Fukuzawa, F.; Ogino, K.; Tomita, M.; Yoshida, K.; Norisawa, K. (Kyoto Univ.). Mem. Fac. Eng., Kobe Univ.; 35: No. 1, 52-78(Jan 1973).

The accelerating tube with diametrically magnetized ring magnets for the bending of backstreaming electrons was constructed for the 4-MV Van de Graaff accelerator of Kyoto University. The x-ray yield due to the electron loading was reduced to a factor of about 100; and the ion beam current was increased by a factor of about five compared with that of the old tube which had plane electrodes with small accelerating apertures. Characteristics of evacuation, beam convergence, and accelerator operation are described. Typical results of ion analysis are given for hydrogen, helium, nitrogen, neon, and argon. (auth)

18986 ENERGY CALIBRATION OF ELECTRONS FROM A 35-MeV LINEAR ACCELERATOR BY NUCLEAR REACTION THRESHOLD. Takeshita, K.; Sunayashiki, T. (Hiroshima Univ.). Nippon Igaku Hoshasen Gakkai Zasshi; 33: No. 1, 58-64(Jan 1973). (In Japanese).

Energies of electrons were calibrated by comparing them with thresholds for nuclear reactions in the range from 12 to 17 MeV and from 27 to 29 MeV. Activity following photodisintegration was measured by a scintillation spectrometer. Oxygen-15 and phosphorus-30 produced in photoneutron reactions were detected by their 0.51 MeV annihilation gamma-rays. Oxygen-14 and aluminum-29 produced in the higher energy range were detected by their characteristic gamma-rays of 2.3 and 1.2 MeV respectively, considering their half lives according to those produced in (γ,n) reactions. Compared to the thresholds, the nominal energies were 0.05 to 0.25 MeV higher in the lower energy range and 0.3 MeV higher in the higher energy range, where the nominal energies were determined by the range measurement method using an ionization chamber in a water phantom. (auth)

18987 DATA ACQUISITION AND TRANSMISSION FOR THE DETERMINATION OF THE BEAM POSITION IN THE 28 GeV PROTON SYNCHROTRON CERN. Schneider, G. Hanover; Technische Univ. (1971). 171p. (In German). Thesis.

Theoretical investigations and the optimization and dimensioning of the beam position measuring equipment at the CERN 28 GeV proton synchrotron are described. For a variety of reasons it was necessary to develop new capacity electrodes for data acquisition, which now require only half of the available sections of the ring periphery, as compared to the systems used up to now, with the resolution of the beam position being almost doubled. Moreover, a new broad-band data transmission system is described that operates without any active electronic elements near the accelerator chamber. Thus the influence of radioactive radiation is reduced considerably. New calibrating methods are used for fast remote control of all 40 measuring points by the control room. The system developed by the author allows the proton beam position to be measured within an accuracy of 1 to 2%. (orig./CB) (GE)

18988 IMPROVEMENTS TO VERY HIGH CURRENT LINEAR ACCELERATORS. Duc Tien Tran. (to Thomson-CSF). French Patent 2,140,839. 9 Jun 1971. 9p. (In French).

Very high current accelerators are constructed in the form of a succession of accelerating cells, each cell being provided with n cavities slightly displaced in frequency with respect to one another. If the energy gain required is sufficiently small that it can be fulfilled by a single cell, then the microwave supply of the constituting cavities does not require any special precautions, the relative frequency adjustment of the cavity being effected with a phase discriminator. This is not the case for an accelerator containing several cells. The parallel microwave supply of the different cavities of the same frequency and the large overvoltage coefficients pose a difficult problem. It is noted that only a slight displacement in frequency of one of the cavities will result in a mismatch between the cavities. The microwave source proposed for the cavities forming the accelerating cells is such that cavities of the same frequency belonging to two successive cells are connected in series by a resonant coupling element, this element having a small overvoltage coefficient. (FR)

18989 DESIGN OF CONTROL SYSTEMS FOR STRIP THICKNESS IN COLD ROLLING MILLS. Troebs, G. BBC-Nachr.; 55: No. 3/4, 62-67(1973). (In German).

For the production of steel, aluminium and non-ferrous metal strips the cold rolling mill is used to cold reduce the strips to their final thickness and thus decides the accuracy to gauge. Gauge control systems are discussed. A brief survey is also given on principles and methods for the strip thickness measurement, including γ and x-ray gages. (GE)

18990 ELECTRON MULTIPLICATION IN CAVITIES. Ben-Zvi, I.; Crawford, J. F.; Turneaure, J. P. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 54-58(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A computer program which simulates the multiplications of electrons in cavities using Monte Carlo techniques has been developed. This electron multiplication program has provided an understanding of the x-ray energy spectrum produced by cavities and of x-ray photographs taken of cavities at high fields. Also, this simulation has predicted two new effects: (1) an electron avalanche multiplication effect which is non-resonant in nature (as opposed to the well known resonant electron multipactoring), and (2) electrons produced in this way tend to form a low energy (on the order of 10 eV) electron cloud near the cavity major diameter. (auth)

18991 RF-TESTS ON DEFLECTING CAVITIES FOR A SUPERCONDUCTING PARTICLE SEPARATOR. Bauer, W. (Univ., Karlsruhe, Ger.); Citron, A.; Dammertz, G.; Eschelbacher, H. C.; Lengeler, H.; Miller, H.; Rithgeber, E.; Diepers, H. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 59-62(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A superconducting S-band RF particle separator is under construction which will be used at the CERN 300 GeV proton synchrotron. It is foreseen to separate particles up to at least 30 GeV/c momentum. A summary of quality factors, (Q), and peak magnetic field (H_p) measurements on several test-deflectors is given. A sequence of surface treatments including electropolishing, anodizing and an UHV-annealing around 1850°C allowed to obtain in a reliable way Q- and H_p-values well above minimum requirements (5×10^8 and 310 Oe respectively). The highest values hitherto obtained for the (high-field) Q and H_p are 4.3×10^8 and 510 Oe corresponding to a mean deflecting field of 3.3 MV/m. The effect of repeated cooling cycles under vacuum and exposure to clean air or methanol was found not to be critical for this range of Q and H_p. The surface resistance depends linearly on an external dc-magnetic field whereas the dependence on the RF field level is much more complicated. With the surface treatment and deflecting modes used, multipacting presents no problem. Breakdowns are nearly always caused by magnetic fields. The frequency tuners foreseen are described. Fine and coarse tuning will be done by separated tuners. They have been tested successfully up to Q-values of 10^9 and peak fields of 390 Oe. Finally a computer program has been written allowing the calculation of multiperiodic deflector modes. An example is shown and compared with a π-mode for uniform periodic structures. (auth)

18992 INVESTIGATIONS OF A SUPERCONDUCTING BEAM TUBE NIOBIUM CAVITY AT S-BAND. Kneisel, P.; Staltz, O.; Halbritter, J. (Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 63-67(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The influence of several surface preparation techniques like electropolishing, chemical edging, anodizing and UHV-heat treatment on both the Q-value and the peak RF fields has been studied in a welded S-band cavity having large beam tubes. Peak magnetic fields up to 650 Oe at a Q-value of 8×10^{10} in the TE_{011}-mode and peak surface electric fields of 25 MV/m at $Q = 7 \times 10^9$ in the T_{010}-mode have been obtained. Simultaneous measurements of the mean free path in the surface layer of the cavity permit to calculate H_{c1}. The results indicate that H_{c1} is no limitation for the magnetic fields achievable in RF-cavities. This makes type-II-superconductors like Nb_3Sn interesting for practical applications at high frequencies. (auth)

18993 SUPERCONDUCTING NIOBIUM CAVITIES PREPARED BY ELECTROPOLISHING AND ANODIZING. Diepers, H.; Martens, H.; Schmidt, O.; Schnitzke, K.; Uzel, Y. (Siemens AG, Erlangen, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 68-70(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Some different surface preparation techniques are applied to TE_{011}- and TM_{010}-X-band cavities machined from solid niobium. The topography of as prepared surfaces is demonstrated by micrographs. A critical magnetic flux density of 160 mT was obtained with a single piece TM_{010}-cavity. (auth)

18994 ELECTRON LOADING IN L- AND S-BAND SUPERCONDUCTING NIOBIUM CAVITIES. Lyneis, C.; Kojima, Y.; Turneaure, J. P.; Nguyen Tuong Viet (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 101-103(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Electron loading has been investigated in superconducting niobium L- and S-band TM_{010} mode single-cell cavities at high field by observing the x-radiation which electrons accelerated by the RF fields produce on collision with a cavity wall. This x-radiation has been studied for various cavity lengths, cavity resonant frequencies, and vacuum and surface conditions. Also, electron loading has been found to produce regenerative excitation of higher modes in both L- and S-band cavities. (auth)

18995 RECENT MEASUREMENTS AT SLAC ON SUPERCONDUCTING NIOBIUM X-BAND CAVITIES. Wilson, P. B.; Farkas, Z. D.; Hogg, H. A.; Hoyt, E. W. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 104-107(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Measurements at 8.6 GHz on TM mode superconducting niobium cavities have been carried out at SLAC in an attempt to establish definitive conditions for reproducibly attaining high peak electric and magnetic fields and high residual Q's. Four cavities, processed by techniques which insure the presence of an oxide layer on the niobium surface before final high temperature outgassing, have given peak magnetic fields exceeding 1000 G and corresponding peak electric fields in excess of 56 MV/m. From this and related experience it is speculated that, in order to achieve high peak fields, carbon present on the niobium surface must be removed through the formation of volatile compounds with oxygen or flucrine during high temperature processing. Data are also presented on the effect on rf properties of exposure at room temperature to various gases. Measurements on anodized cavities are briefly discussed. (auth)

18996 INVESTIGATION OF ADDITIONAL LOSSES IN SUPERCONDUCTING NIOBIUM CAVITIES DUE TO FROZEN-IN FLUX. Piosczyk, B.; Kneisel, P.; Stolz, O.; Halbritter, J. (Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 108-112(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Measurements of the additional losses due to frozen-in magnetic flux have been carried out between 80 and 413 MHz and 2 and 5 GHz. In difference to the results in the GHz-region a not expected stronger temperature and rf-field dependence occurred in the 100 MHz region. (auth)

18997 ELECTRONIC TUNING AND PHASE CONTROL OF SUPERCONDUCTING HELICAL RESONATORS. Hochschild, G.; Schulze, D.; Spieboeck, F. (Univ., Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 116-118(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Further results on electronic tuning of superconducting accelerator structures are given. A new phase control system is reported, where the absolute cavity phase is controlled by a variable reactance using a PIN diode system, while the cavity is locked to a voltage controlled oscillator. (auth)

18998 SUPERCONDUCTING ACCELERATOR MAGNET COOLING SYSTEMS. Vander Arend, P. C. (Cryogenic Consultants, Inc., Allentown, PA); Fowler, W. B. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 119-121(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A cryogenic system has been designed for cooling ~1000 superconducting magnets associated with the proposed "energy-doubler" at the National Accelerator Laboratory. Design parameters, cooling concepts, heat transfer and pressure drops are reported. Even though in final design changes are anticipated, the attempt in this work is to complete a refrigeration design which would accomplish the cooling necessary for the energy doubler magnets. (auth)

18999 QUICK APPROXIMATIONS FOR He_3 POINTS OF STATE. Hall, F. F. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 122-124(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

While studying steady state, very low temperature refrigeration which would be required to permit operation of superconducting RF waveguides, it became evident that operation at about 1.0°K would be more economical than at 1.8°K. This is because the RF losses fall off exponentially in this temperature region. Thus small He_3 refrigerators, together with He_4 cold gas heat shield refrigerators, could be used at 1.0°K rather than large He_4 refrigerators as have been used to attain 1.8°K. Thermodynamic data of He_3 were required to check out these possibilities. (auth)

19000 TITANIUM VACUUM CHAMBER LINERS IN THE CORNELL ELECTRON SYNCHROTRON. Kirschgessner, J. L. (Cornell Univ., Ithaca, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 131-132(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A method is described for constructing and installing solid metal liners inside epoxy filled synchrotron magnets at the Cornell Electron Synchrotron. (auth)

19001 RF LOSSES IN HELICAL RESONATORS. Laslett, L. J. (Univ. of California, Berkeley); Jancaitis, K. S.; Tombrello, T. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 188-190(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A calculational method for prediction of the rf losses and shunt impedance of a helically loaded $\lambda/2$ resonator is outlined. (WHK)

19002 MAIN ACCELERATOR ABORT SYSTEM. Carrigan, R.; DeLuca, W.; Ducar, R.; Lundy, R.; Maschke, A.; Mori, S.; Pelczarski, W.; Rode, C.; Sauer, L.; Teng, L.; Visser, A.; Yamada, R. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 240-242(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The main accelerator abort system is designed to dump the unwanted beam only around the abort system and to reduce the residual radioactivity around the accelerator. The system consists of a 9-ft long aluminum target, a pair of 20-ft long steel collimators, and a pair of fast bump magnets. The beam is aborted within a few milliseconds after the arrival of a trigger signal. (auth)

19003 POWER SUPPLY FOR NAL MAIN RING SYSTEM. Cassel, R. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 355-359(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The NAL main accelerator power system is one of the largest, most powerful, and most sophisticated power supply systems ever developed for accelerators. The system derives its pulsed power directly from the power lines without the use of energy storage. The power is converted through a large number of widely separated individual phase controlled rectifier supplies and regulated to the accuracy of a reference type supply. The hardware, operation, and regulation of this power supply system are described. (auth)

19004 ALL SOLID-STATE LINE-TYPE MODULATOR FOR 10% DUTY FACTOR. Bruinsma, P. J. T.; Heine, E.; Koendrink, G. J.; van Koeverden Brouwer, J. J. (Inst. for Nuclear Physics Research, Amsterdam). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 365-368(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

IKO has recently obtained approval of its proposal to build a high duty factor linear accelerator. Main characteristics of this machine: 500 MeV at 2½% and 250 MeV at 10% d. f. R. F. power is to be obtained from 12 klystrons (100 kW av., 1 to 6 MW peak). A prototype modulator has been constructed. It consists of 48 modules, each of which is a printed circuit 2 kV line-type (50 μs) modulator. Each module feeds a primary winding of a special pulse transformer, in order to supply the 160 kV max. video pulses for the main klystron. The modulator lay-out allows the provision of video pulses, the amplitude of which can be regulated on a pulse to pulse basis with a special purpose processor. Cooling is achieved through the liquid vapor phase change of freon. Details of the system will be given together with first test results. (auth)

19005 KLYSTRONS FOR ACCELERATOR IMPROVEMENTS. Stringall, R. L.; Russell, D. L.; Lebacqz, J. V. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 369-372(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A theory of relativistic large signal rf interaction phenomenon in klystrons has been developed by Tore Wessel-Berg. Based on that theory the SLACKLY computer program was written and is used successfully in the design of improved klystrons for use at SLAC. Good correlation between the predictions of the SLACKLY program and the experimental results has been obtained. (auth)

19006 OPERATION OF THE SPEAR RF SYSTEM. Allen, M. A.; McConnell, R. A. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 373-377(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A brief description of the SPEAR RF system is given including a few additions and modifications, and the operation of the RF system with stored beams is discussed. The improved RF system which is under design and construction, and which will permit operation of SPEAR at 4.5 GeV is described. (auth)

19007 FAST-SPINNING STRIPPER MOD II FOR THE ZERO GRADIENT SYNCHROTRON (ZGS) BOOSTER. Gorka, A. J. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 387-391(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The use of H^- negatively charged particles during injection into the ZGS booster requires the use of a stripping media to convert the particles to H^+ for acceleration in the normal manner. This process of stripping is accomplished with the use of thin plastic foils placed in and out of the acceleration orbit with the use of a unique and novel mechanism. (auth)

19008 THIN FILM MAPPING OF ELECTRON ACCELERATORS. Little, R. G.; Kime, M. B. (Simulation Physics, Bedford, MA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 645-647(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A method for mapping electron accelerator beams employing a blue cellophane thin film dosimeter (TFD) based on optical transmission is discussed. The preparation, handling, exposure and reading of the TFD is elaborated. Examples are given of areal maps and depth dose measurements. An instrument for reading the film is discussed. (auth)

19009 CAMAC CRATE CONTROLLER FOR A SERIAL CONTROL SYSTEM. Barsotti, E. J. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 631-632(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Two years ago the Laboratory was faced with the problem of deciding what type of control system hardware should be used in the Neutrino, Meson, and Proton experimental areas. Realizing that scientists from all over the world would be conducting experiments in these beam lines the Laboratory chose an international standard, CAMAC, as its hardware interface to controlled devices. Because of long distances between control stations a serial control system was necessary. The first attempt at serializing CAMAC was done throughout the two mile long Neutrino beam line. A serial branch driver was designed to interface to commercially available CAMAC type A crate controllers. Due to excessive costs and additional system requirements, another serial system was designed for the Meson and Proton experimental beam lines. The serial crate controller used in this system not only replaces the serial branch driver and type A controller but has two additional features, block transfer and multi-crate addressing capabilities. (auth)

19010 EXPERIENCE WITH TOUCH PANEL CONTROL AT SLAC. Struven, W. C. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 636-637(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF 730310-.

The touch panel man-machine interface system was developed at SLAC to help implement control room consolidation. The decision to consolidate the two accelerator-research area control rooms was made in 1970 in order to increase operating efficiency. An acoustical touch panel was proposed and developed. A crosswire touch panel was implemented when it appeared that it could be produced more quickly and at a lower cost. Eight cross-wire systems and one acoustic system were installed as control surfaces in the Main Control Center. These control surfaces are mounted over standard C.R.T. video monitors to form the control-display unit. This method of control and display was chosen over competing systems such as light-pen units because of the ease of control. Light-pens become a burden when several displays are mounted side-by-side. The operator is required to make many changes on all three units of a group and the use of light-pens would be too time consuming. The touch panel method of control is made possible by a Data Disc Storage drum connected to an SDS-925 computer. The Data Disc has a complete character generator and appropriate drivers for the C.R.T. displays. "Touches" are sensed by the SDS-925 computer and "read" as operator requests. A button typically selects another panel, selects a pattern (trigger pulse), turns a device on or off or raises or lowers a voltage or current. All controls go to the accelerator via a DEC PDP-9 computer in the Central Control Room (CCR). (auth)

19011 IU ACCELERATOR CONTROL SYSTEM DIGITAL MULTIPLEXER. Zinneman, T. E.; Bardin, B. M. (Indiana Univ., Bloomington). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 616-617(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A digital distribution system has been constructed at the Indiana University cyclotron facility to link the control computer, an XDS Sigma 2, with the three stages of the accelerator and the control console. This system consists of a network of modular digital multiplexers attached to a common bidirectional data bus. When fully expanded, the system can transmit or receive 16-bit data words to or from 1024 different devices. In addition, a device may generate a computer interrupt by raising 1 of 256 available status bits. The multiplex system was implemented with XDS T series modulus and thus is compatible with any DTL or TTL logic. (auth)

19012 COMPUTER CONTROL OF THE OAK RIDGE ISOCHRONOUS CYCLOTRON. Ludemann, C. A.; Domaschko, J. M.; Mosko, S. W.; Hagemann, K. (Oak Ridge National Lab., TN). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 618-620(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The controls of the Oak Ridge Isochronous Cyclotron are being interfaced to a computer system. The initial implementation of the system is designed to reduce the time for setting up the cyclotron between experiments and to closely monitor the operation of the accelerator's power supplies. The system will be expanded to include the monitoring and control of the RF, beam-line, and vacuum systems. Later, diagnostic devices will be interfaced so that beam quality and intensity may be optimized. The operator communicates with the cyclotron via a CRT interactive display and a control console containing reassignable function keys and LED readout devices. The computer is a Modular Computer Systems MCS III/5. Operation data and programs for controlling the cyclotron are stored on disc and magnetic tape libraries. (auth)

19013 SYSTEM FOR MONITORING PROTON LOSSES FROM THE NAL MAIN ACCELERATOR. Lundy, R. A.; Sutter, D. F. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 596-598(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The National Accelerator Laboratory (NAL) Main Ring Beam Loss Monitor System employs ~200 inexpensive liquid scintillation detectors distributed evenly around the accelerator circumference to measure radiation created when protons strike vacuum chamber walls, obstructions, magnets, etc. The detectors are interfaced to the computer control system through 10 channel "sample and hold" electronics which also integrate and amplify incoming pulses. Since the computer system can arbitrarily select the times during a machine cycle when sampling will occur, it is possible to generate real time graphs of radiation loss versus time, radiation loss versus machine circumference, or a three dimensional histogram combining the two. (auth)

19014 FAST RF STRUCTURE MONITOR. DeBall, L. M.; Suddeth, D. E. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 599-601(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A number of high energy physics experiments are based on a random distribution of particles entering the experimental apparatus. Unfortunately, the extracted beam from a proton synchrotron will display a bunching due to the RF cavity. However, this bunching can be reduced or destroyed by various techniques; such as, by introducing noise into the RF cavity during extraction, or by lengthening the energy loss target. Therefore, in order to measure the effectiveness of these various techniques, a monitoring system is needed to detect the amount of RF structure present in the extracted beam. The design of the RF structure monitor used at the Zero Gradient Synchrotron (ZGS) is described. Further, the results obtained from using this system are discussed. (auth)

19015 AIR-FILLED ION CHAMBER BEAM LOSS MONITORS FOR THE ZERO GRADIENT SYNCHROTRON (ZGS). Suddeth, D. E. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 602-604(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Small, air-filled, ion chambers have been constructed to serve as localized beam spill monitors. They are mounted at the downstream end of each straight section of the ring and are useful for locating beam obstructions and for finding spills due to abnormal machine adjustment. The chamber is made up of thin aluminum sheets with mylar insulation and is enclosed in a lucite box. No preamplifier is used, but the signals are transported to the Main Control Room (MCR) via RG-22/U shielded pair to maintain good SNR. A central 300 V power supply provides ion collection potential for all eight chambers. The signals are processed for individual and multiplexed monitoring. (auth)

19016 DERIVED RADIAL POSITION AND WIDTH SIGNALS FROM A TV BEAM VIEWER. Suddeth, D. E. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 605-607(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A beam viewer which displays in near real time the brightness, width, and position of the beam at the Zero Gradient Synchrotron (ZGS) is described. This consists basically of a calibrated phosphorescent screen which nondestructively collects ions generated by the circulating beam. A closed circuit TV system transports the signal to the Main Control Room. Circuits were developed which derive analog voltages representative of the beam width and position from the synchronization and video signals. The brightness vs. horizontal position linearity was improved by vidicon model change and a simple shading circuit. A calibrator which simulates a beam was built into the system and is invaluable for initial setup and linearity tests. (auth)

19017 BEAM PHASE LOCK USING AMPLITUDE LIMITED PULSE COMPARISON FOR THE ZERO GRADIENT SYNCHROTRON (ZGS). Suddeth, D. E.; Bohringer, D. E. (Argonne Na-

tional Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 608-609(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Solid state high frequency limiter amplifiers and fast rise time voltage comparators for pulse shaping make zero crossing time a meaningful phase reference. A circuit based on these principles was developed and is in use in the beam phase feedback loop of the ZGS. It has excellent linearity for voltage out vs delay for up to 50° with a phase error of <8° for the following input condition: input voltage amplitude from 0.1-2.0 V and beam bunch rate from 4.4 to 14.0 MHz. A detector is included to insure a zero output reference when there is no beam or when beam levels are below the phase-lock threshold. (auth)

19018 FAST TECHNIQUE OF MEASURING EQUILIBRIUM ORBIT WARPS IN THE ZERO GRADIENT SYNCHROTRON (ZGS) AT INJECTION. Bogaty, J. M. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 610-612(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The difference signals from radial pi induction electrodes located in the eight straight section boxes of the ZGS are used to determine equilibrium orbit warps. A 1 μs, debunched linac beam is injected in the ZGS ring and the eight coasting beam signals are analyzed. Since the effective electrode centers and inflector magnet positions are known, one can obtain orbit positions around the ZGS ring. The zero crossing times of all eight coasting beam bow-tie patterns are entered into our CDC-924A computer. The computer graphically displays orbit warps via CRT terminal. An additional feature to be described is that betatron tunes at injection can be very easily obtained from the coasting beam patterns. (auth)

19019 RF PHASE CONTROL SYSTEM. Sundelin, R.; Von Borstel, E.; Tigner, M. (Cornell Univ., Ithaca, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 593-595 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A system for automatically controlling the instantaneous phase of the accelerating voltage at each of the six accelerating stations at the Cornell 12 GeV Electron Synchrotron has been developed. The phases are controlled to ±5° relative to a master oscillator. The system comprises electronic phase shifters to compensate for variations in klystron phase shifts during the acceleration cycle, and mechanical phase shifters to compensate for drive cable delay variations. Near full energy, when different klystron modulator waveforms are used in each station, the phase control provides an effective increase of 20% in RF power by cancelling the 180° phase shift which occurs in each klystron as it is brought up to full power. The phase control system is also a great aid in obtaining correct phasing when more than one station is used to pick up the beam. (auth)

19020 COMPUTER-BASED VISUALIZATION AND MANIPULATION OF ORBIT WARPS IN THE ZERO GRADIENT SYNCHROTRON (ZGS). Knott, M. J.; Crosbie, E. A. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 584-586(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The low energy orbit warps in the ZGS are corrected by eight current-regulated single-turn kicker windings. The currents regulated in these coils can be set individually by the operators through a central digital control system. Since large first harmonic warps are produced by small current changes in single coils, blind, individual adjustment of the eight currents is seldom productive. A computer program and interactive graphic display system which allow accelerator operators to visualize the effects of single or multiple kicker coil current changes are described. The display provides numeric as well as graphic representation of the orbit warp produced. Localized orbit bumps can be inserted by specifying location and size. The program can be used for off-line visualization purposes only, or optionally the desired currents can be introduced immediately by the computer. (auth)

19021 SOME EFFECTS OF (NOW HAVING) COMPUTER CONTROL FOR THE STANFORD LINEAR ACCELERATOR. Mallory, K. B. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 541-543(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The development of the computer control system is outlined, and problems resulting from the delay of installation of the computer are discussed. (WHK)

19022 DETECTION OF OPTICAL TRANSITION RADIATION AND ITS APPLICATION TO BEAM DIAGNOSTICS. Wartski, L. (CNRS, Orsay, France); Marcou, J.; Roland, S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 544-548(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Optical transition radiation produced by 40 to 60 MeV electrons crossing thin metallic foils has been studied in order to provide a beam diagnostic device. The radiation yield is roughly one photon per 100 electrons and the intensity appears to be Z independent; the influence of bremsstrahlung is then fairly weak. Measurements of angular and γ dependence, spectral density and polarization have been carried out and results are in good agreement with theories. When multiple scattering angles are negligible ($<\gamma^{-1}$), a strong energy dependence, close to γ^3, of the light intensity radiated into small solid angles is found. Moreover, the radiation is peaked in a direction making an angle γ^{-1} with the beam axis. (Suitable optical arrangement makes possible beam position and profile determination.) Measurement of the polarization plane rotation by means of a scanning mirror provides a method of determining the incident angle of the beam onto the target. This device looks promising for diagnostics on particle beams-electrons as well as protons- with normalized energies γ in the range 1 to 10^3. (auth)

19023 MEASUREMENT OF BUNCH-LENGTH BY A MODE-LOCKED LASER WITH A TIME RESOLUTION OF 10 PICOSECONDS. Fischer, R.; Rossmanith, R. (DESY, Hamburg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 549-551(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In accelerators working at accelerating frequencies of several 100 MHz the bunch length is in the order of several hundred picoseconds. For obtaining good measurements the time resolution of the measuring apparatus should be 10 ps. With convenient electronic components such a high time resolution cannot be obtained. A method is described for measuring the bunch length optically by measuring the time structure of the light emitted by relativistic particles (synchrotron or Cherenkov radiation). The heart of the system is a wideband Nd^{3+}-Glass Laser emitting infrared light at 1.06 μm. With a special technique, the so-called mode-locking, the laser is forced to emit high-intensity optical pulses of several GW peak power and a pulse-length of about 5 ps. These pulses enter a cell filled with a Kerr medium, e.g., CS_2, and induce birefringence. Since the relaxation time of CS_2 is small, the birefringent zone travels with c/n through the Kerr medium. Combined with two polarizers the system works like a camera with a slit-shutter traveling at the velocity of light. By photographing, a total time resolution of 10 ps is obtained. (auth)

19024 MODULAR CONTROL SYSTEM UTILIZING CAMAC HARDWARE FOR INTERFACING REMOTE COMPONENTS AT NAL. DeLuca, W. H.; Maier, A. J.; Michelsen, J. E.; Swoboda, C. A. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 552-554 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The diversification and physical remoteness of components constituting the NAL proton beam switchyard and site-wide fire detection systems necessitated the use of mini-computers to centralize monitoring and control. Devices are interfaced to the computers by series connected local controllers. The local controllers utilize a standard CAMAC crate with a simplified dataway to achieve economic modular construction. Serial data transfers are used between controllers for reliable operation in a high noise environment. Bulk data transfers to the Switchyard System Computer are implemented on a special high speed serial link which operates independent of, but initiated by, the local controllers. A special Minicontroller module with an emergency back-up power source is used to monitor NAL fire detection systems. These Mini's are continuously scanned and tested by the Fire System Computer which presents status and alarms on strategically located terminals. (auth)

19025 PLOTTING OF BEAM VARIATION WITH Q VALUE ON THE 5 GeV ELECTRON SYNCHROTRON NINA. Marks, N.; Hughes, E. A. (Daresbury Nuclear Physics Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 555-557(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The development of a diagnostic technique that explores the variation of beam with injection Q value is described. The auto-

mation of the method is described, and some preliminary results are presented and discussed. (auth)

19026 Q MEASUREMENT WITH SWEPT RC FILTER FOR AUTOMATIC DATA ACQUISITION AND DISPLAY. Potier, J. P.; Schneider, C. C.; Schulte, E. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 564-566(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An automatic Q measurement system ($Q = f_{betatron}/f_{revolution}$) which was developed and installed at the 28 GeV Proton Synchrotron of CERN is described. At the desired moment the beam is excited to 1 mm betatron oscillations by means of a programmed full aperture air kicker. The frequency spectrum which appears at a beam position pick-up station contains the non integer part of the Q value as the lowest frequency. A voltage controlled RC filter scans the pick-up signal spectrum. When the lowest frequency of the spectrum is attained, a feedback loop switches the filter to a constant frequency. The ratio measurement (normalization to the revolution frequency) is performed by counting the doubled acceleration frequency during 10 periods of the filter output frequency. The counter output is fed to a computer which displays after data handling the Q value on an alphanumeric cathode ray tube. The measurement time for the acquisition of the horizontal or vertical Q value is less than 1 ms. The resolution of the measurement is $\Delta Q = 0.001$. (auth)

19027 PRECISION NON-LINEAR ANALOG TRANSFER FUNCTION GENERATOR. Tool, G. S. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 567-569(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A technique for generating driving waveforms having non-linear dependence on an independent variable is described. Forward biased high-conductance silicon diodes are used as feedback elements in an operational amplifier circuit. A FORTRAN time-sharing computer program has been written and used to aid in the selection of circuit components. A ratio frequency program generator has been designed and built to provide the drive to a voltage-controlled oscillator as a function of the NAL main accelerator bend magnet current. (auth)

19028 FACT BEAM PULSING SYSTEM FOR THE STOCKHOLM 225-cm CYCLOTRON. Abrahamsson, K.; Filevich, A.; Rensfelt, K. G.; Sztarkier, J. (Research Inst. for Physics, Stockholm). Nucl. Instrum. Methods; 111: No. 1, 125-132(1973).

A fast pulsing system for the Stockholm 225-cm cyclotron has been built and put into operation. An electric field between a pair of plates is used for sweeping the external beam up and down, in synchronism with the frequency of the cyclotron. One pulse out of three, four or five of the naturally pulsed beam is allowed to pass through a slit after a 2-m drift space. The system is dimensioned to handle beams of particles with mass-to-charge ratios ≤3.3 and energies ≤12.5 MeV/nucleon. The design and construction of the system are described and some results from measurements of half-lives and g-factors are presented. (auth)

19029 BOOSTER AND MAIN ACCELERATOR PHASE DETECTOR SYSTEM FOR CAVITY TUNING. Higgins, E. F. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 570-572(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Each NAL booster and main accelerator rf station contains a phase lock control loop to resonate the beam-line cavities at the applied excitation (reference) frequency. The phase sensor in the loop is a dual channel phase detector having an octave bandwidth, an amplitude dynamic range of 60 dB, a phase balance vs. frequency better than ±2° and a zero crossover phase sensitivity of 0.18 V/deg. The phase detector develops a feedback "error" signal proportional to the phase difference between the rf reference signal and an rf signal representing the rf station beam line voltage. The rf cavity tuning feedback loop configuration is discussed, and the details of the phase detector circuitry are described. (auth)

19030 BEAM MONITORING IN THE EXTRACTION REGION OF THE NEVIS SYNCHROCYCLOTRON. Aslanides, E.; Cohen, R. C.; Dugan, G.; Nagourney, W.; Rosenstein, L.; Slagowitz, M.; Ziegler, K. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 573-575(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A secondary emission monitor has been designed and tested for use in beam profile measurements of the extracted proton beam of the Nevis Synchrocyclotron. The monitor will provide a non-destructive simultaneous measurement of the vertical and horizontal position distributions, with a resolution of ~0.1 in. A residual gas ionization counter has been also designed. This counter will measure the radial profile of the accelerated beam at the parking radius. (auth)

19031 CONTROLS FOR OPERATING AND PROCESSING THE MIT–LNS LINAC. Weaver, J. N. (Massachusetts Inst. of Tech., Middleton). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 576-579(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The Central Control Room for the MIT Linac is designed for simplicity of operation (one man) with an eye on future use of a computer to set the desired operating parameters. A natural summing of local controls around the five RF driver/dual-modulators and the injector/master oscillator control room allows one to switch to the display and control of the six areas one at a time with a trunk line. The distributed parameters (magnetics, radiation and RF phase monitoring) are mostly monitored and controlled directly from CCR with pushbutton selection of each parameter. Also mentioned are the detailed results of RF processing the 7 m, S-band accelerator sections with 15 μs, 4 MW pulses at repetition rates exceeding 1000 s^{-1} and phase tuning the rectangular waveguide networks using a combination of the SLAC method and beam loading maximization. (auth)

19032 MECHANICAL DESIGN OF A DELAY LINE FOR THE ASTRON LINEAR ACCELERATOR BEAM TRANSPORT. Hurley, C. A. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 491-492(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The Astron concept for thermonuclear research requires a layer of circulating electrons of sufficient density to confine and heat a plasma. This layer, called the E-layer, is formed by an accelerator injecting 6 MeV electrons at a 4° angle from perpendicular. The accelerator produces a 600 amp pulsed beam of 300 ns duration. A delay line has been built for the purpose of increasing the peak injection current. The 300 ns pulsed beam is split in half by a kicker and the first half is delayed so it can be injected on the opposite side of the trapping solenoid simultaneously with the second half of the beam. Thus two short pulses of 150 ns each are injected into Astron with one pulse traveling through a transport system of five bends and straight sections. (auth)

19033 NEW APPROACH TO SHIELDING CALCULATIONS FOR VERY HIGH ENERGY ACCELERATORS. Van Ginneken, A.; Awschalom, M. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 459-461(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A new Monte Carlo program, CASIM, has been written specifically to solve high energy hadron shielding problems. The program starts from inclusive distributions of nucleons and pions from nuclear interactions and generates averages (over many incident particles) of particle fluxes and energy deposition throughout the shield. Within this limitation the program has several advantages over other shielding calculations: (a) quite complicated source terms (e.g., Hagedorn's thermodynamical model) can easily be used, (b) weighting techniques permit following cascades over large distances as well as examining of selected geometries, heterogeneous media, etc., (c) short coding and (d) short execution times. Results of CASIM are presented for protons incident on realistic geometries as well as an intercomparison of predictions for a solid beamstop using two different production models. As examples of CASIM's capabilities, three shielding cases of interest in accelerator radiation safety are presented: (a) a solid steel backstop; (b) a solid concrete backstop; and (c) an iron target in a concrete cave. In addition, comparison of the star density distributions in steel for 300 GeV incident protons using two different hadron source terms are shown. (auth)

19034 PRELIMINARY OBSERVATIONS ON THE RESPONSE OF ACCELERATOR SHIELDING BLOCKS TO EARTHQUAKE MOTIONS. Godden, W. G. (Univ. of California, Berkeley); Peregoy, W.; Aslam, M.; Scalise, D. T. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 462-464(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The importance of establishing rational design criteria for accelerator shielding blocks to protect against accidents during earthquakes is discussed, and preliminary testing methods and results are mentioned. (WHK)

19035 TESTS AND DESCRIPTION OF BEAM CONTAINMENT DEVICES AND INSTRUMENTATION: A NEW DIMENSION IN SAFETY PROBLEMS. Walz, D.; Busick, D.; Constant, T.; Crook, K.; Fryberger, D.; Gilbert, G.; Jasberg, J.; Keller, L.; Murray, J.; Seppi, E.; Vetterlein, R. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20; No. 3, 465-471(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The destructive capability of the beam power of some accelerators was dramatically demonstrated in a series of tests at SLAC using an 18 GeV e^- beam at average powers ranging from 165 to 880 kW. The purpose of the experiments was to examine a series of devices which simulated beam stoppers, protection collimators and burnthrough monitors as presently applied at SLAC. Specific attention was given to the recording of burnthrough times, temperature behavior, and to the analysis of failure modes. A summary of the test data is presented. The design of an extensive electronic system to prevent damage to mechanical devices and to detect onset of destruction is discussed. Various sensors are connected to integrating and peak reading circuits to form power, beam verification and errant beam monitors. Burnthrough monitors shut down the accelerator if damage occurs to critical items. New features such as self-checking, protected wiring and rapid on-line calibration are described. (auth)

19036 NAL BOOSTER SYNCHROTRON MAGNET POWER SUPPLY SERVO. Donaldson, A. R.; Winje, R. A. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 409-410(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The booster magnet power system operates 48 magnet modules for equilibrium orbit field control. The power system consists of four high current power supplies having a common thyristor firing control chassis. The power supplies were manufactured by Brentford Electric Ltd. The magnet energizing current waveform is $I(t) = I_{dc} - I_{ac} \cos 2\pi ft$, where f is the 15 Hz series resonant frequency of the high Q circuit. The dc and ac components are generated with one power source, not two as in earlier designs for rapid-cycling synchrotrons (e.g., NINA, DESY, CEA, PPA, and Cornell). Magnet power system parameters are summarized. (auth)

19037 PERFORMANCE OF TRANSDUCTORS FOR PRECISION HIGH CURRENT MEASUREMENT AND CONTROL. Fuja, R. E.; Praeg, W. F. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 411-413(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In order to find transductors suitable for the requirements of the ZGS, four commercial transductors were compared with a precision coaxial shunt. The results of these measurements, which determine the stability, linearity, hysteresis, frequency response, output ripple, coefficients of temperature and line voltage, and effects of magnetic stray fields, are reported. (auth)

19038 NAL QUADRUPOLE POWER SUPPLY ACTIVE FILTER. Yarema, R. J.; Cassel, R. L. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 414-415(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A 40 kW active filter is used with each of the main accelerator's 12 quadrupole power supplies to reduce the power supply's voltage ripple. The active filter operates on a voltage-bucking principle with the filter output transformer coupled into the quadrupole magnet bus. The filter electronics is designed to respond to the first three harmonic components of ripple in the power supply output. Voltage ripple attenuation during injection, acceleration, and extraction is approximately 30 dB. Quadrupole magnet current ripple is correspondingly reduced. (auth)

19039 NEW RF SYSTEM FOR THE ORIC. Mosko, S. W. (Oak Ridge National Lab., TN). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 416-417(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The Oak Ridge Isochronous Cyclotron RF system has been converted from an RCA 6949 power amplifier to an RCA 4648 power amplifier. The primary incentive was to reduce tube replacement cost; however, improved system performance and reliability were also realized. Existing servo-tuned driver amplifier stages and RF voltage regulator loops were retained. Typical accelerating potential noise levels are about 0.05% to 0.1% peak to peak noise per peak RF voltage. (auth)

19040 2ND RF SYSTEM FOR NIMROD. Sandels, E. G.; Church, R. A.; Gardner, I. S. K.; Whitby, H. C. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 418-421(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An additional high power RF system has been built for Nimrod to provide an 8th harmonic accelerating field i.e., the 2nd harmonic of the main RF. Its purpose is to reduce the bunching factor of the proton beam thus increasing beam acceptance and accelerated intensity. In the accelerating cavity a drift tube is tuned over a frequency range from 2.8 MHz to 16 MHz by two ferrite loaded resonators. The configuration adopted proved to have considerable advantages over a self-contained tuned cavity particularly for assembly and access, permitting economy in the use of ferrite. The problems discussed include that of covering a wide tuning range while restricting the magnetic flux in the ferrite, suppressing unwanted modes in the cavity and maintaining accurately the phase and amplitude of the harmonic field relative to the main RF. (auth)

19041 TWO MEGAWATTS RF POWER TETRODE. McNees, S. G. (EIMAC, San Carlos, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 422-423(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Several years ago EIMAC with in-house funds undertook to develop a super power tetrode capable of generating 2MW RF power continuously at frequencies up to 50 MHz. The design of this tube, called the X2159, is based on the successful concepts which were developed for the 4CW50,000E and the 4CW100,000E. Although the super power tetrode uses proven design concepts a scale up of approximately ten times in power presented its problems. These can be summed up as increased power per unit area and the mechanical problem of maintaining close tolerances. Operating characteristics are given. (auth)

19042 PRIMET: A VERSATILE ACCELERATOR TIMING SYSTEM. Swoboda, C. A.; Daniels, R. E.; Lau, H. C.; Tummilo, A. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.). Trans. Nucl. Sci.; NS 20: No. 3, 653-655(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The control systems at NAL extend over distances in excess of 10 miles. In order to synchronize machine events, not necessarily time related, it is essential that the same timing information be provided to all areas. Various methods of implementing a timing system which would provide accelerator event reference times were considered. A single line clock transmission system, using a serial encoding feature, proved to be the most economical and practical. It is easy to implement, reliable, and provides versatility while maintaining a degree of simplicity. All that is required to transmit this encoded clock to different areas of the accelerator are clock repeaters and a single cable. In general, the encoded clock is connected to either computer or manually controlled timing modules which act as preset counters. The serially encoded information is selectively detected by these modules and used as acclerator event reference times. Any one of 14 reference times can be used as a timing pulse or as a start signal to the module, which then produces a pulse delayed from the selected reference by a predetermined amount of clock counts. (auth)

19043 ORBIT MEASUREMENT SYSTEM OF THE CERN 800 MeV PS BOOSTER. Rabany, M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 656-658(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The electrostatic pick-up beam position measurement system has been designed to satisfy a large number of requirements: observation of beam trajectory; reduction of coherent oscillations; Q measurement; closed orbit measurement; and accelerated beam position. The special four superposed rings configuration of the booster and the value of $Q(4 < Q < 5)$ leads to a minimum of 16×4 ring position sensors to satisfy those requirements. In order to compute Q values right at injection the system has been foreseen for acquisition of the full orbit on two consecutive revolutions. (auth)

19044 800 MeV MEASUREMENT LINE OF THE CERN PS BOOSTER. Baribaud, G.; Metzger, C. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS 20: No. 3, 659-661(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The CERN 800 MeV PS Booster consists of 4 superimposed synchrotrons which are filled in multiturn injection by double pulsing the present CPS injector, a 50 MeV linac. After RF-trapping 20 bunches of protons (5 per ring) are accelerated in about 0.6 s to 800 MeV. The 4 beams are then sequentially fast ejected and vertically recombined for transfer to the 28 GeV PS. A dump line, branching off the transfer line, was foreseen to dispose of the beam during any operation of the PSB without transfer to the CPS. It seemed attractive to make use of the necessary bending for spectrometry and to check in this line the quality of recombination. Thus, the dump line was promoted to a measurement line with the threefold purpose of emittance measurement, spectrometry, and transport of the beams to a dump. The measurement line is described. (auth)

19045 HIGH ENERGY LOW INTENSITY BEAM PROFILE MONITOR. Chehab, R.; Ngoc, C. N. (Paris Univ., Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 662-664(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The principle of this monitor—used in beam emittance measurements on transport lines—is based on secondary emission phenomenon in dielectric layers. Thin aluminium strips covered with low density KCl layer are used. Measurements with electron beams in the range 150 to 400 MeV are made with foils and strips in the region of stable operation. Observations upon avalanche multiplications encountered are also reported. (auth)

19046 WIDE BAND CURRENT MONITOR BASED ON PULSED TRANSFORMER TECHNIQUES. Sutter, D. F. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 665-667(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A charged-particle beam current monitor has been designed using a coaxial cable transmission line in a configuration similar to that employed in building toroidal-wound wide band impedance matching and balun transformers. Several sizes of the coax-wound monitors have been constructed and compared with units of similar ferrite core material and geometry that were wound with ordinary magnet wire. One of the transformers has been used by experimenters at the NAL Internal Target area since August of 1972. In order to simplify electronic signal processing, only average circulating charge is measured. This is done by measuring the "zero signal" baseline shift due to the natural L/R response of the transformer. (auth)

19047 RESULTS OF PHYSICAL TESTS ON POLYMER MATERIALS AT CRYOGENIC TEMPERATURES. Van de Voorde, M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 693-697(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The mechanical and thermal properties of polymer materials which may be used as electrical insulators and constructional materials in magnets for high energy physics applications have been studied in a temperature range from 4.2°K to 300°K. Some of these polymers have been irradiated up to 2×10^8 rad in liquid nitrogen and liquid neon and the same properties were subsequently tested. A brief description of the various testing techniques is given. (auth)

19048 COMPUTATION OF POLEFACE WINDING SYSTEMS YIELDING INDEPENDENT MULTIPOLE FIELDS WITHIN THE APERTURE OF NOTABLY ALTERNATING GRADIENT SYNCHROTRON MAGNETS. Asner, A. (CERN, Geneva); Holsinger, R.; Iselin, C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 703-707(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The computations for a poleface winding system capable of creating independent quadrupole, sextupole, octupole, and higher-order fields which would consist of n conductors along the pole contour, supplied from n + 1 separate power supplies are presented. The study was undertaken for developing high-intensity injection and accelerating systems for the 28-GeV CERN Synchrotron. (WHK)

19049 RADIATION RESISTANT MAGNET COILS FROM HARD ANODIZED ALUMINUM CONDUCTOR. Holland, M. M.; Shill, J. (Columbia Univ., Irvington, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 708-712(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An extracted beam current of ~25 μA of ~575 MeV protons from the modified Nevis Synchrocyclotron will strike two meson producing targets before coming to rest in a beam stop. The quadrupole and dipole transport magnets viewing the targets at close range might absorb 10^{10} to 10^{11} rad/yr or more. Conventional coil insulating techniques employing epoxy, fiberglass, alumina filled matrices can withstand, at best, a total absorbed dose of a few times 10^{10} rads. Therefore, a coil fabrication and insulating method depending entirely upon inorganic materials was developed. The coils are fabricated from hollow aluminum conductor which is wound, hard anodized, and assembled. Hard anodized aluminum sheets serve as additional layer to layer and ground insulation and inorganically bound mica mat is used between turns. (auth)

19050 MODIFICATION OF LINDA TO TREAT THE GRAIN ORIENTATION EFFECT. Endo, K.; Kihara, M.; Takasaki, E.; Kasuga, T.; Igarashi, T. (National Lab. for High Energy Physics, Ibaraki, Japan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 716-718(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An approximate method of dealing with the grain orientation effect in oriented low carbon steel has been investigated. This has been applied to the field computation of the main ring quadrupole magnet of KEK-PS. (auth)

19051 DESIGN OF DIPOLE MAGNET WITH CIRCULAR IRON SHIELD. Lee, W. W.; Snowdon, S. C. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 726-728(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Complex variable function theory is used to formulate the magnetostatic problem of a rectangular current block of uniform current density located within a circular region bounded by infinite permeability iron. The magnetic field from the superposition of several blocks arranged to exhibit dipole symmetry is calculated using a generalization of Cauchy's integral formula. Subsequent multipole expansion yields expressions for the multipole coefficients which through the use of variable metric minimization permits block arrangements to be found for rather pure dipole fields. Application is made to superconducting dipoles for both a pancake arrangement and a shell arrangement of the individual blocks. (auth)

19052 ZERO GRADIENT SYNCHROTRON COIL FAILURES IN 1970–1971, ANALYSIS AND SUBSEQUENT REMEDIAL ACTION. Martin, J. H.; Jovanovic, D.; Lewis, L. G.; Pewitt, E. G.; Praeg, W.; Sevcik, V. J. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 729-730(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The main magnet of the Zero Gradient Synchrotron (ZGS) consists of eight 53-ft long coils numbered around the ring sequentially beginning at the point of injection of the 50 MeV proton beam from the linac. On April 21, 1970, octant 2 coil failed after 41 million pulses. On January 9, 1971, octant 3 coil failed after 45 million pulses. Somewhat after the failure of the second coil, a committee consisting of the authors of this paper was formed to determine why the coils failed, to predict the future relative to coil failures, and later to make recommendations for specifications for new spare coils and protective measures against further coil failures. A summary of the committee efforts and a coordination of several papers which have been written dealing with parts of the findings and actions taken are given. (auth)

19053 IMPROVEMENTS IN THE ZERO GRADIENT SYNCHROTRON (ZGS) MAIN MAGNET COIL PROTECTION. Suddeth, D. E.; Praeg, W. F.; Potts, C. W. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 731-733(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Two main coil failures in a one-year period initiated a review of on-line protective circuitry. Two existing circuits, which would limit damage, were made more reliable. Four new circuits were added to monitor coil condition and protect against voltage transients. (auth)

19054 MAIN MAGNET COIL DIAGNOSTIC TESTS AT THE ZERO GRADIENT SYNCHROTRON (ZGS). Suddeth, D. E. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 734-736(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

To establish a meaningful history of the electrical condition of the main magnet coils, various instruments and techniques were developed for a diagnostic program. (auth)

19055 PRELIMINARY MODELING AND TESTING OF RAMPED SUPERCONDUCTING DIPOLES FOR THE NAL DOUBLER. Reardon, P. J.; Strauss, B. P.; Sutter, D.; McCracken, R.; Richied, D.; Otavka, M. A. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 744-746(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A brief description of tests and results on two types of superconducting dipole magnets is given. The magnets studied were a multilayer pancake geometry and a concentric shell configuration. (WHK)

19056 PULSED QUADRUPOLE SYSTEM FOR PREVENTING DEPOLARIZATION. Bywater, J.; Khoe, T.; Lari, R.; Potts, C.; Praeg, W.; Ratner, L. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 869-871 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A pair of pulsed quadrupoles spaced 180° apart in the Zero Gradient Synchrotron (ZGS) ring was installed to prevent the depolarization of polarized protons during acceleration in the ZGS. These quadrupoles must produce a 50-G/in. gradient over a useful aperture of 2 in vertically and 10 in radially. The pulse must have a 10-μs rise time and a $2\frac{1}{2}$-ms flattop. They must be pulsed up to ten times during the $1\frac{1}{2}$-s ZGS acceleration period. The computer calculations and the mechanical and electrical design and fabrication of the quadrupoles and their power supply are described. (auth)

19057 CORRECTING CLOSED-ORBIT DISTORTION IN THE NAL MAIN RING. MacLachlan, J. A. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 892-894(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The position of the equilibrium orbit in the NAL synchrotron is measured by sensors immediately downstream of ring quadrupoles. The orbit distortion is corrected at low magnetic field by dc correction magnets located adjacent to the sensors and at high field by transverse displacements of the ring quadrupoles. The inconvenience of moving quadrupole magnets has favored making the minimum number of moves necessary to obtain adequate reduction of the maximum orbit distortion. A few familiar mathematical techniques have proved adequate to calculate the correcting moves, but the combination of these techniques is data dependent. A computer search program invariably gives a solution, but it has been useful to experiment with weighting and smoothing of the data and to compare alternative calculations to insure that the solution is optimum with respect to priorities and constraints. (auth)

19058 CLOSED ORBIT CORRECTION IN SPEAR. King, A. S.; Lee, M. J.; Morton, P. L. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 898-899 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The position of the closed orbit in SPEAR is affected by the field errors and the alignment errors in the magnets. Deviations of the beam orbit from the ideal position are detected by the 20 position monitors located at approximately every quarter betatron wavelength along the orbit. The closed orbit errors as measured by these monitors can be corrected by using appropriate localized beam bumps at some of the magnets chosen as correcting elements. A computer program MOVQ has been written to find an "optimum" set of magnets to be used as correctors and to calculate the strength of the beam bump for each corrector. The values of the field strength for the correctors are chosen such that the sum of the squares of the orbit deviations is minimized. This program has been used successfully for SPEAR orbit corrections. A brief description of the computational procedure used in MOVQ is given, and some results are presented. (auth)

19059 SUBNANOSECOND HIGH-INTENSITY BEAM PULSE. Mavrogenes, G.; Ramler, W.; Wesolowski, W.; Johnson, K.; Clifft, G. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci.; NS-20: No. 3, 919-922(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The design and installation of a new bunching system for the Argonne electron linear accelerator originally placed into operation in 1969 has been completed. It now routinely produces a pulse as short as 40 ps in duration with a charge of at least 7 nC (180 A in amplitude) for use with experiments in the very "short" time reaction region. Such a pulse is produced over an energy range of 4 to 20 MeV with an accompanying total energy spread of 300 keV. Frequency of production is variable from one single pulse up to a PRR of 800 P/s. Efficiency of acceleration from the gun to the output of the accelerator is 50%. Details of the bunching system, including the method of calculation with space charge inclusion, geometrical factors and hardware, and operational results are given. (auth)

19060 OPERATION OF A HIGH GRADIENT RECIRCULATING rf ACCELERATING CAVITY. Kirchgessner, J. L.; Tigner, M. (Cornell Univ., Ithaca, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 928-931(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In order to increase the peak energy of the Cornell Electron Synchrotron from 10 to 12 GeV, it has been necessary to add approximately 10 MV per turn of acceleration. The system which provides this additional rf acceleration is described. (auth)

Ion Sources and Injection and Extraction Systems

19061 (AD-758640) 5 MV RADIAL INSULATOR ELECTRON GUN FOR AN ELECTRON RING ACCELERATOR. Condon, J. J.; Lupton, W. H. (Naval Research Lab., Washington, D. C.) Mar 1973. 24p. (NRL-MR-2569). NTIS.

A massive radial insulator is considered as an approach for a stable mounting of a vacuum diode electron gun and connection of a 5-MV, 70-ohms, oil dielectric pulse generator. A rationale for determining the electric field permitted without breakdown along the insulator-vacuum interface is presented. The electric field along this interface and on the center conductor is determined by numerical solutions of Laplace's equation for specific models. A dished head and field shaping collar make it possible to operate a 4.5 ft diameter insulator at 5 MV. The rise-time due to the shunt capacitance of the electron gun is calculated to be 13 ns. A proposal is made to design and construct such a radial insulator from cast nylon. An external magnetic field must be used to prevent vacuum breakdown and limit the current from the cathode stalk. The electron gun impedance cannot be calculated at this time. (auth)

19062 SINGLE- AND DOUBLE-DRIFT BUNCHES AS POSSIBLE INJECTION SCHEMES FOR THE CPS LINAC. Bru, B.; Weiss, M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 963-965(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Two bunching schemes are considered in the frame of the CPS linac, one with a single buncher, the other with a double-drift harmonic buncher. The matching of the beam to the linac acceptance in six phase-space dimensions is achieved by computer programs in an iterative way: zero current solutions are found first, and then the intensity is progressively raised until 200 mA are trapped into the linac. (auth)

19063 BETATRON. Ananev, L. M.; Pekker, Ya. S.; Chachlov, V. L.; Sarasin, Ya. A.; Stein, M. M.; Yaruskin, Ya. Ya. (to Tomskii Politechniceskii Institut). German Patent 1,934,852. 14 Jan 1971. Filed date 9 Jul 1969. (In French).

A betatron is described which contains an injector with an emission cathode characterized by the fact that the winding of the cathode of the injector is placed in the main electro-magnet in such a way that it includes the magnetic flux produced by the electromagnet. (TSS)

19064 USE OF NONLINEAR RESONANCES OF BETATRON OSCILLATIONS FOR SLOW EXTRACTION OF PARTICLES. Fedotov, Yu. S. At. Energ. (USSR); 33: No. 4, 844(Oct 1972). (In Russian).

This paper was summarized as paper No. 615/6547 with full copy held by TIC.

Nonlinear resonances of betatron oscillations are widely used in systems for slow extraction of particles from accelerators. The results obtained in investigating the dynamics of series of nonlinear resonances to be used for slow extraction are given, and expressions suitable for calculating the basic parameters of the system are given. (WHK)

19065 RAPID CYCLING VALVE FOR 30-Hz PULSED H^- ION SOURCE. Gorka, A. J.; Moenich, J. S.; Kellogg, K. D. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 127-129(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

This valve is used to reduce the gas loading on the vacuum system of a multipulsing H^- ion source. It is a self-aligning chopper type. A mechanism of this construction assures the reliability required for an ion source of this nature. The reliability of this mechanism is due to the fact that the disc of the chopper is rotated at a relatively slow constant velocity and no wearing parts of the assembly are subjected to the extreme vacuum atmosphere. The entire valve assembly is very simple in construction. It is driven with a synchronous motor to keep it in step with the accelerating frequency. Vacuum integrity is maintained with the use of a ferromagnetic fluid coupling as part of the drive system. All bearings, motors, and drive mechanisms are external to the vacuum cavity. (auth)

19066 PRESSURE DIFFERENTIAL GATE VALVE. Moenich, J. S.; Peerson, J. J. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 130(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A $1\frac{1}{2}$ inch isolation gate valve to prevent vacuum vessel letup to atmosphere in the event of ion source component failure is described for the tandem acceleration extended stationary arc duoplasmatron used for 1 pulse/s H^- injection into the ANL booster. (WKH)

19067 SOME ADVANCES IN NEGATIVE ION TECHNOLOGY. Purser, K. H. (Univ. of Rochester, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 136-141(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Some properties of negative ions, ways in which the properties of potential negative atoms or molecules may be predicted, and some of the recent advances in negative ion source technology are reviewed. (24 references) (WHK)

19068 DESIGN AND OPERATION CHARACTERISTICS OF THE DEVELOPMENTAL H^- ION SOURCE FOR 30-Hz INJECTION INTO THE ARGONNE NATIONAL LABORATORY (ANL) BOOSTER. Fasolo, J. A.; Gorka, A. J.; Moenich, J. S. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 142-146(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A tandem-acceleration extended stationary arc duoplasmatron used for 1-Hz injection into the ANL booster is undergoing further development for 30-Hz operation. A 200-μs, 50-MeV H^- beam of at least 4 mA at 30 Hz will be required by the booster in its final development phase. To meet this requirement and to offset losses occurring in the linac and in the 750-keV and 50-MeV beam lines, the source must provide about 10 mA of H^- ions. The present source produces negative ion currents of this order but the H^- component is typically only 50% of the total beam; the remainder of the beam consists of ions with mass numbers in the neighborhood of 17. Source design is discussed and data are presented for typical operating conditions on the test bench and in the 75-keV terminal of the preaccelerator. Physical and chemical properties of materials which affect their suitability for use in pulsed ion sources as load-bearing structural materials, as functional components, and as vacuum walls are also discussed. (auth)

19069 PRODUCTION OF INTENSE PROTON BEAMS. Hanley, P. R.; Wells, N. (Radiation Dynamics, Inc., Westbury, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 182-184(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An ion source system employing mass selection has been developed for use in the terminal of an accelerator. The beam from a duoplasmatron is accelerated to 40 keV and focused by an einzel lens through a 20° permanent magnet inflector. A beam waist is formed at a 6.35 mm rejection aperture located on the acceleration axis. Dispersion is sufficient to provide a proton beam of greater than 99% purity. Proton currents up to 7 mA were obtained during bench testing. Performance demonstrations on the Dynamitron accelerator at the University of Birmingham have shown proton beam power in excess of 6 kW at energies from 2 to 3 MeV. (auth)

19070 OPERATING RESULTS FROM THE ANL BOOSTER. Simpson, J. D. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 198-201(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The former Cornell 2.2-GeV electron synchrotron has been moved to Argonne, modified, and recommissioned as a developmental booster injector for the Zero Gradient Synchrotron (ZGS). The machine uses H^- stripping injection to obtain circulating intensities normally impossible to achieve with conventional proton injection techniques. Results of tests performed to date are discussed in this report. (auth)

19071 PRESENT PERFORMANCE OF THE CERN 800 MeV PS BOOSTER (PSB). Bovet, C. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 221-225 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The CERN 800 MeV PSB consists of four synchrotrons stacked one on top of the other. The injector is the present 50 MeV CERN Proton Synchrotron (CPS) linac. Its beam is injected sequentially into the four rings via a vertical distribution system. Monoturn or multiturn injection of up to fifteen turns is available. After acceleration to 800 MeV, the four beams are ejected sequentially and brought to a common level by a recombination system. All twenty bunches are then transferred to the CPS, thus potentially increasing its intensity to 10^{13} p/p. Construction started in 1968, running-in on 1 May, 1972. Experiments on injection, acceleration, and transfer to the CPS were carried out whilst completing the installation of beam observation systems, debugging the interface to the IBM 1800 control computer, and bringing the software to operational standard. Closed orbit deviations are less than anticipated (only a few mm). Linear coupling and sum resonances were studied with a beam coasting at injection energy: they can be compensated with a small fraction of the available correction strength. Multiturn injection, RF trapping efficiency, acceleration, synchronization, ejection, and transfer to the CPS are described in their latest stage. At the end of the year the design intensity of 2.5×10^{12} p/p was reached in one ring. (auth)

19072 S. I. N. INJECTION CYCLOTRON. Baan, A.; Beelaard, R. A.; Hazewindus, N.; Hovers, H. J. A. M.; van Niewland, J. M.; Wierts, D. (Philips Gloeilampenfabrieken, Eindhoven, Netherlands). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 257-259(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A 250 cm pole diameter isochronous cyclotron is under construction for the Swiss Institute for Nuclear Research (S. I. N.). The design goal is described followed by a brief discussion of the machine. (auth)

19073 PRODUCTION AND DYNAMICS OF HIGH INTENSITY ELECTRON BEAMS. Brautti, G. (Univ., Bari, Italy); Boscolo, I.; Coisson, R.; Leo, M.; Luches, A.; Tepore, A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 286-288 (5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

High intensity electron beam experiments are in progress at electron energies varying from 100 keV to 2 MeV. The low energy machines are Marx generators, while the high energy one is an electron beam transformer accelerator, homemade with some original technical solutions. Its electron energy is 2 MeV, current > 10 kA, pulse length 20 ns at a repetition rate of 10 pps. The purpose is injection in the ANEL-type electron ring accelerators, beam dynamics and plasma-beam interaction investigations. Several models of field emission diodes have been investigated by various diagnostic methods and beam pictures on various materials have been taken. (auth)

19074 INJECTOR FOR MARYLAND ERA PROJECT: DESIGN FEATURES AND INITIAL PERFORMANCE. Burton, J. K. (Naval Research Lab., Washington, DC); Condon, J. J.; Lupton, W. H.; Derosier, F. L.; Greenwald, A. C.; Henness, J. M., Rhee, M. J.; Zorn, G. T. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 321-323(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An injector has been built at the University of Maryland which produces a hollow cylindrical beam of relativistic electrons. The design uses a low-impedance pulse generator and step-up, transmission-line transformer to drive a high-impedance, field-emission electron gun. The design of the pulse generator and performance of the pressurized gas switches are reviewed. The transformer and electron gun design is also described and results are given for the initial tests of the injector with a 2-MeV, 6-kA beam. (auth)

19075 SYNCHRONOUS TRANSFER OF BEAM FROM THE NAL FAST CYCLING BOOSTER SYNCHROTRON TO THE NAL MAIN RING SYSTEM. Dinkel, J. A.; Griffin, J. E.; Hubbard, E. L.;

Peters, R. E.; Teng, L. C. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 351-354(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (4 Mar 1973). See CONF-730310-.

The beam from successive cycles of the 15-Hz booster synchrotron is stacked end to end in the main synchrotron with constant magnetic field. The beam already injected into the main ring is held in stationary rf buckets, and the rest field is determined by the circulating beam. To capture the beam from subsequent booster cycles into the empty buckets in the main ring, the phase and frequency of the rf beam bunches in the booster are locked to the main ring rf system before the beam is transferred. The magnetic fields in the booster and the main ring are regulated separately and tuned for the correct orbit radii and particle momentum. The azimuth of the beam circulating in the main ring is monitored by counting main ring rf cycles, and the beam transfer system is timed to inject the beam from successive booster cycles in the correct sequence around the main-ring circumference. (auth)

19076 RESONANCE INJECTION IN THE SUPERCONDUCTING STRETCHER RING. Khoe, T. K.; Lari, R. J. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 392-394(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The shortest pulse length of the beam extracted from the Zero Gradient Synchrotron (ZGS) is of the order of 50 μs so that multiturn injection into the stretcher ring is needed. The conventional method of using a programmed dipole bumper magnet to move the equilibrium orbit away from the septum magnet results in a considerable dilution of the radial phase space. This dilution is very much reduced if a sextupole field is added to the perturbation. Because of this nonlinear field, the radial phase space is divided into two regions. The region inside the separatrix is stable. The extent of this stable region is determined by the strength of the dipole and sextupole fields. Initially, the dipole field is large enough to cause this stable region to disappear completely. During injection, the dipole field is steadily reduced so that the stable region reappears and increases in size. By an appropriately located septum magnet, the particles are injected in the neighborhood of an "incoming" trajectory of the separatrix. Depending on the initial conditions, the particles are captured in the expanding stable region. (auth)

19077 ZERO GRADIENT SYNCHROTRON (ZGS) HIGH ENERGY POLARIZED PROTON BEAM PROGRAM-INJECTOR SYSTEM. Parker, E. F.; Madsen, J.; Sesol, N.; Stockley, R. L.; Timm, R. E. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 395-396(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The injector system for the ZGS polarized proton program is diagrammed. Conceptually, the system is quite straightforward. It consists of a 750-keV preaccelerator, PA-II, with a high gradient accelerating column, a beam transport line, and beam monitoring devices coupled to the existing 50-MeV linac. The system is, in fact, not very straightforward as a result of the physical size and complexity of the ion source, the very low beam current, the need to measure a new beam parameter (polarization), and the operational requirement that both PA-II and the regular ZGS preaccelerator, PA-I, operate simultaneously. (auth)

19078 R. F. MODULATED ELECTRON GUN FOR NINA INJECTION EQUIPMENT. Poole, D. E.; Charlesworth, T. R.; Gunnill, O.; Peters, D. G.; Saxon, G. (Daresbury Nuclear Physics Lab., Warrington, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 399-400(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Operation and performance of an 80 keV electron gun, rf modulated for correct phase space acceptance in NINA after preacceleration in a 40-MeV linac injector, are described. (WDK)

19079 NEW METHODS FOR MULTITURN INJECTION INTO SYNCHROTRONS. Meads, P. F. Jr. (William M. Brobeck and Associates, Berkeley, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 401-402 (Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Equations for the matched betatron phase space acceptance polygon for the nth turn and for the phase area swept out by the septum are derived. A variable rate of shifting of the equilibrium orbit past the septum is considered with the object being to maximize the accelerated charge subject to a constraint on the permissible beam cross section at full energy. Also, spiral stacking-a method of systematic laying of successive-turn phase space ellipses along a logarithmic spiral in matched radial phase space which results in uniformly dense packing of the beam with losses is described. The beam is injected above the median plane and placed along the spiral through a programmed displacement of the equilibrium orbit. (auth)

19080 CONTROL OF ION SOURCES FOR THE ZERO GRADIENT SYNCHROTRON (ZGS). Timm, R. E. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 613-615(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A controls' philosophy used during research, development, and operation of ion sources for the ZGS has been instituted. The total control design concept aids in the learning curve during research, development, and the turnover to the operational group. The system is designed for manual control, central computer control, and programmer computer control. The operational multiplicity is achieved by time sharing and priority interrupt assignments. Individual control console design varies with source complexity, but basic functions are similar. (auth)

19081 ORTHOGONAL AUTOMATIC STEERING INTO THE ZERO GRADIENT SYNCHROTRON (ZGS) USING ACHROMATIC MAGNETS. Timm, R. E. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 587-589(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In the past, steering of the 50-MeV proton beam into the main ring of the ZGS was performed empirically. The method was unsatisfactory because of the heterogeneity of the magnet adjustments. An algorithm was developed that described the orthogonal position of the beam in terms of exit position, exit angle, and position in the center achromat. Any combination of steering parameters can be made by adjustment of the achromatic magnets. The necessary modes of operation, functions, and readouts are combined in a consolette. The consolette is interfaced with the central control computer as an on-line, time-shared input/output (I/O) device. When a steering change is desired, the computer, via stepping motors, adjusts the four magnets for the required solution. (auth)

19082 NEW DIAGNOSTIC SYSTEM FOR STUDYING THE INJECTOR AND INJECTION AT THE ZERO GRADIENT SYNCHROTRON (ZGS). Kustom, R. L.; Parker, E. F.; Potts, C. W.; Wehrle, R. B.; Brumwell, F. R. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 518-522(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A segmented Faraday cup beam monitoring system for making quantitative measurements of ZGS beam injection parameters is described. The relative energy, energy spread, emittance of the injector beam and injection angle, injection and capture efficiency as a function of betatron amplitudes, first harmonic orbit wasps at injection, and the injection radial tune can be determined. (WHK)

19083 BEAM DIAGNOSTICS SYSTEM, SERVING THE SERPUKHOV FAST EJECTION. Cuperus, J.; Fabiani, F.; Kamber, I.; Nuttall, J. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 523-527(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A set of beam transformers measures the intensity of each bunch, circulating or ejected. Five electrostatic pick-ups measure the radial position of one selected bunch. Secondary emission grids and luminescent screens give the profile and position of the beam at relevant points. Gated radiation detectors monitor beam loss in the ejection area. All signals are digitalized and fed to a minicomputer on line. Readout is via nixies, CRT analogue displays, pen recorders and a teletype. Statistics can be made over a chosen number of acceleration cycles. (auth)

19084 OPERATION OF THE NAL MAIN RING EXTRACTION SYSTEM. Bleser, E. J.; Edwards, H. T.; Fisk, H. E.; Hornstra, F.; McCarthy, J. D.; Oleksiuk, L. W.; Peoples, J. Jr.; Rode, C. H. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 502-504(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The NAL Main Ring extraction system has delivered both slow and fast extracted beam at 100, 200, and 300 GeV. Construction progress, operating conditions, instrumentation and beam characteristics are discussed. (auth)

19085 SIMULTANEOUS RESONANCE EXTRACTION. Crosbie, E. A.; Khoe, T. K.; Lari, R. J.; Ratner, L. G. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 434-437(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Simultaneous extraction of the ZGS beam at two experimental areas (EPB-1 and EPB-II) using the integral resonance $3\nu_x = 2$ is described. Simultaneous resonance extraction was verified experimentally at a total efficiency of 45% on small beams. (WDK)

19086 FAST SHAVING EJECTION FOR BEAM TRANSFER FROM THE CPS TO THE CERN 300 GeV MACHINE. Bovet, C.; Fiander, D.; Henny, L.; Krusche, A.; Plass, G. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 438-441(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A fast shaving ejection during 10 or 11 turns is the most promising system for the transfer of the CPS beam to the 300 GeV machine under construction for which the CPS is to be the injector. The scheme uses a pair of fast kickers which shift the beam in 10 or 11 steps across an electrostatic septum, located at a position where the amplitude function is increased to near 100 m and the momentum compaction function reduced to near zero. A prototype system has been installed in the CPS and tests have been carried out at 10 GeV/c with bunched and adiabatically debunched beams. The stability of the operation, ejection efficiency, emittance and momentum spread of the ejected beam are of major interest and have been measured. The test results are in agreement with theory and no serious difficulties have been observed. (auth)

19087 HALF-INTEGER RESONANCE EXTRACTION FOR THE NAL ACCELERATOR. Edwards, H. T.; Lee, W. W.; McCarthy, J. D.; Ohnuma, S.; Teng, L. C. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 424-427(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The slow extraction from the main ring at NAL utilizes the half-integer resonance at $\nu_x = 41/2$. Extraction elements are three quadrupoles and one octupole. Two quadrupoles control the tune during the extraction while the third one is used to compensate for the tune fluctuation, thereby reducing the amount of the beam intensity modulation. The turn separation is produced by the average octupole field in the ring as well as by the special octupole which is located in phase with extraction quadrupoles. The size of turn separation is also controlled by a local bump in the closed orbit near the extraction septum. The beam has been extracted with the spill time up to 700 ms and with the efficiency of 85 to 90%. Together with a pinger, it is also possible to extract over 90% of the beam in less than 400 μs. (auth)

19088 PULSED FERRITE INFLECTOR FOR THE EMITTANCE MEASURING DEVICE OF THE CHALK RIVER HIGH CURRENT TEST FACILITY. Pachner, J. Jr. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 405-406(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A pulsed ferrite inflector for fast injection of the 750 keV, 100% duty factor proton beam of the Chalk River High Current Test Facility (HCTF) into an emittance measuring device (EMD) is described. Tests with a low voltage prototype of a pulser have shown that a flat pulse top can be achieved by grading a lumped delay line (serving as a pulse forming network) with small additional capacitors, and that the pulse fall time can be substantially reduced by a tail biter, which at a given time diverts the current from the magnet coil and at the same time opens the primary switch of the pulser. (auth)

19089 ELECTRICAL DESIGN OF A SMALL SOLID STATE ENERGY DISCHARGE POWER SUPPLY. Visser, A. T.; McCarthy, J. D.; Rode, C. H. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 407-408(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The construction of a solid state, voltage regulated energy discharge power supply with a dual output for feeding short current pulses to aircore magnets located around a ceramic section in NAL's main ring beam pipe is briefly described. Each output operates at about 1800 V dc, and 7800 A peak. Charging voltage regulation, and set level, are obtained by means of a solid state relay at the primary site of the single phase high voltage rectifier transformer. This method yields a relatively inexpensive, simple system since it does not require phase control circuitry. (auth)

19090 SPACE CHARGE EFFECTS IN THE VERTICAL PLANE DURING INJECTION IN A SYNCHROCYCLOTRON. Thouroude, D. (Univ., Rennes, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 880-881(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The evolution of the beam during capture time is followed by means of numerical methods. The space charge field is obtained by constructing, for purposes of calculation, a rectangular network in the beam. All particles of a given parallelepiped are replaced by a single macroparticle of equivalent charge placed at the centre of the parallelepiped. The field produced by all the macroparticles is then calculated at the knots of the network. The field at any other place is found by interpolation. Beam shapes and distribution of particle densities have been calculated in this way for the CERN synchrocyclotron, at various instants in the vertical plane. The mean accelerated current is calculated. (auth)

Ion Optics and Field Calculations

19091 (LA-tr-73-38) PARAXIAL THEORY OF INTENSE RELATIVISTIC ELECTRON BEAMS. Parish, D.; Ryl'tsev, P. I.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). Apr 1973. Translation of JINR-P9-6700. 23p. Dep. NTIS $3.25.

One of the main technical problems in contemporary accelerator technology is the creation of intense beams or dense blobs of charged relativistic particles. Thus, for example, in the realization of the ideas of collective methods of acceleration there arise the problems of creating electron bands of small size with a number of particles $N_e \approx 10^{13}$ or greater and electron beams with a current of tens of kiloamperes, of containing the dimensions of these beams and bands at the large distances covered by them or with long intervals of time, and of control of the parameters of the beams at particle energies of 3 to 4 MeV and greater. Solution of the indicated technical problems without concrete engineering calculations does not seem to be possible. In this a consideration of the effect of the initial spread of the beam parameters and the behavior of the phase space, as well as the oscillations arising in the beam, is especially important. The paraxial theory in its usual form operates with linearized differential equations. For the outer fields, which resolve into a rapidly converging series, linearization gives a good approximation. However, taking into account the eigen fields causes the appearance of nonlinearities of another nature, the simple linearization of which can mean a wide departure from reality. Therefore, starting from the very general equations of movement, it is attempted to give a paraxial theory of intense beams of a somewhat expanded form and then the results obtained are analyzed. (auth)

19092 (N-73-16677) MAGNETIC-FIELD MEASUREMENTS FOR THE LEWIS RESEARCH CENTER CYCLOTRON. Fessler, T. E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1973. 52p. (NASA-TM-X-2692; E-6956). NTIS.

The magnetic field of the Lewis Center cyclotron was mapped by using a Hall-effect magnetic-field transducer. Main-field Fourier coefficients were determined on a polar mesh of 40 radii for each of seven levels of main-field coil current. Incremental fields for eight sets of trim coils and two sets of harmonic coils were also determined at four of these main-field levels. A stored-program, digital computer was used to perform the measurements. The process was entirely automatic; all data-taking and data-reduction activities were specified by the computer programs. A new method for temperature compensation of a Hall element was used. This method required no temperature control of the element. Measurements of the Hall voltage and Hall-element resistance were sufficient to correct for temperature effects. (auth)

19093 (TID-26368) HIGH-GRADIENT COLUMN COMPUTER PROGRAM CALLED KALUM. Concaildi, G. A.; George, R. D. (Argonne National Lab., Ill.). 1 Mar 1973. 6p. Dep. NTIS $3.00.

A CDC-924 computer program called KALUM for tracing phase-space figures through the acceleration volume within an electrostatic column is described. (WHK)

19094 (TID-26369) OPERATION MANUAL FOR PROGRAM "LARI". Concaildi, G. A. (Argonne National Lab., Ill.). 9 Apr 1973. 5p. Dep. NTIS $3.00.

Beam stacking in the radial betatron phase-space can be studied by the use of the program LARI. This program was rewritten and translated for its use on the CDC-924A control computer. The program was formerly known as TKK6 on the SEL-810A computer. It is an interactive program which uses a CRT and exists in a background environment. (WHK)

19095 BEAM BREAKUP IN A 55-CELL SUPERCONDUCTING ACCELERATOR STRUCTURE. Mittag, K.; Schwettman, H. A.; Schwarz, H. D. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 86-90(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Longitudinal and transverse beam breakup defines an upper limit to the beam current that can be attained in a linear accelerator. In a superconducting accelerator (SCA), the problem of regenerative beam breakup is particularly important because the inherent Q-values of the relevant modes are extremely large. On the other hand, the problem of cumulative beam breakup in a SCA is comparable to that in a conventional electron linac. The regenerative beam breakup characteristics of the 55-cell multiperiodic structure which is the basic unit of the SCA being developed at Stanford are described. The breakup characteristics of the capture section and the pre-accelerator section have been described previously. In these studies it is demonstrated that the relevant breakup modes can be selectively loaded, and that the starting current for regenerative beam breakup in a SCA can be increased to 500 μA, a value well in excess of the initial design objective of 100 μA. (auth)

19096 SELF FIELDS AND PARTICLE OSCILLATION FREQUENCIES IN A ROTATING ELECTRON SHEET BEAM LOADED WITH POSITIVE IONS. Reiser, M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 318-320(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An approximate analytical treatment is presented for the electric and magnetic self fields of a long rotating sheet beam between coaxial conductors. By suitable choice of the conductor radii and/or by applying a voltage between the conductors it is possible to shift the potential minimum to the major radius of the beam; the condition for this is derived. Expressions for the equilibrium fields and gradients and for the particle oscillation frequencies in various geometries are presented. (auth)

19097 STOPPING OF AN ELECTRON RING BY INDUCED IMAGE CURRENTS IN RESISTIVE WIRE LOOPS. Kalnins, J. G. (Univ. of Maryland, College Park); Kim, H.; Linhart, J. G. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 324-326(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The possibility of trapping an electron ring in the Maryland ERA by use of a few resistive wire loops was investigated numerically. It was found that a resistive wire of 45 ohm resistance and 404 nh self-inductance was able to stop electron rings of 10^{13} electrons with initial axial velocities up to $\beta_{z0} = 0.05$. A scheme, with two resistive wires and a small local mirror field, allowed the trapping and focusing of electron rings of small axial dimension. Electron rings with relatively large axial lengths were also studied. (auth)

19098 ENVELOPE INSTABILITIES IN RELATIVISTIC ELECTRON RINGS. LeVine, D. M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 327-329(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The possibility of resonant coupling of the transverse degrees of freedom of concentric electron and ion rings has recently been demonstrated for the case of stationary ions and relativistic electrons apropos of the E. R. A. configuration. In contrast to the "dipole" or "kink" instability, this transverse instability results from perturbation in the ring's cross-section with fixed center of mass and exhibits unstable bands as a function of electron and ion density. The existing analysis assumes beams of circular cross-section and neglects one of the transverse degrees of freedom in order to obtain a tractable dispersion equation. Extention of this analysis is reported to include the case of elliptic cross-section, and numerical solutions are obtained of the resultant dispersion equation including all of the degrees of freedom. The extended analysis also yields band-like regions of instability and is in agreement with the previous work for the special case of circular cross-section; however, in the case of elliptic cross-section, the bands shift their position and shape relative to those at circular cross-section and split into pairs of bands where only one was reported previously. The motion of the bands as a function of cross-section is such as to suggest the possibility that this instability may be self-stabilizing. (auth)

19099 NEGATIVE MASS INSTABILITY IN HOLLOW CYLINDERS. LeVine, D. M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 330-332(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In analyses of the negative mass instability for electron rings it is assumed that the azimuthal electric field, E_θ, and the perturbed charge density are proportional. The proportionality factor depends on the detailed structure of the ring and tank and with proper normalization is referred to as the geometry factor. Calculations of this geometry factor are reported for an electron ring in a perfectly conducting, infinite cylinder in a manner which takes into account the shape of the ring and the image effects due to the walls. This is done by employing a normal mode expansion for the electromagnetic fields in the cylinder in the form of a dyadic Green's function which satisfies the appropriate boundary conditions on the walls of the cylinder. The calculations are carried out explicitly for a ring of major radius, R_0, centered on the cylinder's axis and with rectangular cross-section and uniform charge density. The value of E_θ at R_0 is used to determine the geometry factor, and this geometry factor is then used to investigate the negative mass instability following the formulation of Landau and Neil. The analysis yields both real and complex values for the geometry factor. (auth)

19100 GENERATION AND DIAGNOSIS OF TW/cm^2 ELECTRON BEAMS. Pellinen, D. G.; Heurlin, S. E. (Physics International Co., San Leandro, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 333-335(5 Mar 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Pulsed electron accelerators driving small cathodes have been used to generate self-focusing beams with power densities well in excess of 10^{12} W/cm^2 and current densities in excess of 1 MA/cm^2. These beams appear to follow conventional space charge limited flow dynamics which predict a divergent beam until the diode current exceeds a critical current, $I_C = I_A \beta_0 \gamma_0 R/d$, when the beam focuses sharply into the center. Immediately after the focus, the diode current is the parapotential current, $I_p = R/d\, I_A \gamma_0 \ln[\gamma_0 + (\gamma_0^2-1)^{1/2}]$, and increases as anode debris approaches the cathode. Theoretical considerations predicting more intense focusing at higher voltages is discussed and compared with experimental results. Diode impedances measured to date have been in the 10 to 40 ohm range which is compatible to source impedances on existing large accelerators. (auth)

19101 POLE FACE WINDING (PFW) EQUIPMENT FOR EDDY CURRENT CORRECTION AT THE ZERO GRADIENT SYNCHROTRON (ZGS). Studdeth, D. E.; Schmitt, D. R.; Timm, R. E.; Wright, A. J. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 397-398(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The titanium vacuum chambers installed in the ZGS this past summer were equipped with PFW's. The operation and monitoring of the windings used to flatten the guide field in the ZGS are described. The physical and electrical characteristics of the system are discussed along with a computer program which calculates the magnetic field shape in the vacuum chamber as a function of PFW current and other machine parameters. (auth)

19102 BEAM TERMINOLOGY. Schumacher, B. W.; Fink, J. H. (Westinghouse Research Labs., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 403-404(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An analysis of a thermionic electron beam is presented and some deficiencies in the concepts of brightness and emittance are pointed out. Radiance and Richtstrahlwert are found to be better terms. (auth)

19103 MINIMIZATION OF ABERRATIONS IN BEAM LINE DESIGN. Carey, D. C. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 493-495(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The aberrations present in a beam line represent the departure from the ideal first-order design. Such aberrations may be of second and higher order. Individual second-order terms may be represented by a matrix T. A formalism for representing the net contribution of such terms to the beam dimensions is derived. Corrective elements such as sextupoles or non-linearities in bending magnets may be employed. A method for minimizing the effects of second-order aberrations has been derived. This method has been incorporated into the program TRANSPORT. Higher-order effects may now arise from the coupling of second-order terms. A computer program TURTLE is used to evaluate such effects. (auth)

19104 SPACE CHARGE EFFECTS IN HIGH CURRENT LINEAR ACCELERATOR TRANSPORT SYSTEMS. Mavrogenes, G.; Khoe, T.; Wesolowski, W. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 478-480(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The transverse and longitudinal effect in short high current RF buckets of cylindrical geometry and uniform charge distribution are considered in free space. Two cases are examined (a) The beam is radially constructed (magnetically) and (b) The beam is free both radially and longitudinally. Transverse expansion of a beam in space with a non-symmetrical conducting boundary is presented. (auth)

19105 NEW APPROACH TO THE TRANSPORT OF HEAVY CHARGED PARTICLES. Youssef, E. A.; Vermeulen, F. E.; Chute, F. S. (Univ. of Alberta, Edmonton). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 442-446(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A study has been made of the focusing and guiding properties of a long electrostatic quadrupole structure that has been uniformly twisted about its axis. It is demonstrated that compared to the classical chain of quadrupole triplets, the twisted structure is inherently more strongly focusing and can accept more widely divergent particle beams. (auth)

19106 PROPERTIES OF DISC-LOADED LINES. Gallagher, W. J. (Physics International Co., San Leandro, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 952-956 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The microwave properties of disc-loaded cylindrical waveguides has been measured for both three and four discs per guide wavelength and normalized phase velocities from 0.5 to 1.0%. A graphical presentation of the results is given. A discussion of other results quoted from the technical literature is also included. (auth)

19107 PROPERTIES OF CONTOURED CAVITIES. Olcese, J. J.; Gallagher, W. J. (CNEA, Buenos Aires). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 957-959(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Mesh relaxation computer programs such as the Los Alamos LALA have been developed which determine the Q, shunt resistance and resonant frequency of radially contoured, cylindrical cavities supporting a TM 01-like mode. This program has been used in particular to optimize accelerator cavity designs for the sidecoupled standing wave structure. However, it is also possible to use these cavity designs for in-line structures. In this case $\beta p = (V_p/C)\pi$, so that, for example, the longitudinal $2\pi/3$-mode at the velocity of light corresponds to the phase velocity 0.66 in the standing wave notation. It is convenient to regulate the energy velocity in this structure by means of circumferential slots between cells, leaving the beam aperture unchanged. The results of experimental measurements to determine the properties of such a structure in the $2\pi/3$-mode are presented. (auth)

19108 BEAM LOADING OF RF CAVITIES. Gallagher, W. J. (Physics International Co., San Leandro, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 960-962(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An analysis of the microwave properties of an rf cavity, including the effects of beam interaction, is given. The analysis includes the effect of input coupling mismatch and transient conditions. The principal result is that the energy gain must be represented by a cubic expression rather than the quadratic form applicable to traveling wave structures. (auth)

19109 EQUIVALENT CIRCUIT FOR A PERTURBED MULTI-CELL STRUCTURE. Jule, W. E.; Gluckstern, R. L. (Univ. of Massachusetts, Amherst). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 943-948(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A study to determine the appropriate equivalent circuit for a multi-cell structure and to compare its predictions for dispersion curves and sensitivity to perturbations with those obtained with less rigorously derived equivalent circuits is described. An equivalent circuit and a dispersion relation for a periodic Alvarez type linear accelerator using the approach of Bevensee is derived. This apprcach starts from Maxwell's equations with the fields expanded in the normal modes appropriate to the structure. The equivalent circuit that these equations imply is different from the equivalent circuit used by many other authors. While many circuits lead to a single passband dispersion relation, it is not obvious that they each give an identical dispersion curve. If these circuits are modified to allow for perturbations, they may not in general predict the same frequency shift and the same changes in the gap fields for the same perturbations. In order to compare the circuits, the frequency shift and the changes in the gap fields are computed using a multi-cell field formulation. It is shown that the two circuit models are not equivalent, and that the Bevensee model with a frequency dependent coupling parameter gives more accurate predictions for the perturbed quantities. (auth)

19110 GENERAL DESIGN EQUATIONS FOR ISOCHRONOUS CYCLOTRONS. Jain, A.; Divatia, A. S. (Bhabha Atomic Research Centre, Trombay, India). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 902-904(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In a multiparticle variable energy cyclotron there exists a unique sector shape which will provide optimum focusing and isochronism for the full range of particles to be accelerated. To generate this shape, general hard edge equations for the orbit properties are presented. The equations for the betatron frequencies hold for the case when (i) the entry and exit spiral angles are unequal, (ii) the hill and valley fields vary with the radius, and (iii) for separated sectored cyclotrons also, with the valley field equal to zero. A series of mc^2 type spiral sectored electron cyclotron magnets have been constructed and the hard edge equations have been evaluated against orbit integration results in the measured fields. (auth)

19111 PREBUNCHING WITH SPACE CHARGE. Olcese, J. J.; Gallagher, W. J. (CNEA, Buenos Aires). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 895-897(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A systematic study of single gap prebunching, including the effects of space charge, has been undertaken, using the second moment of the charge distribution as a measure of bunching action. Generalities of the bunching process are discussed. (auth)

19112 NORMAL OSCILLATING MODES OF A ONE-DIMENSIONAL MAXWELLIAN BEAM IN THE LINEAR SPACE CHARGE APPROXIMATION. Besnier, G. (Univ., Rennes, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 882-884(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Following a method used in plasma physics, a Fourier-Hermite transform is attempted to solve the linearized Vlasov-Poisson equation for small fluctuations of a stationary beam. This expansion method is well fitted to the case of a maxwellian beam confined by linear external forces. As a first approximation, if one retains only the linear part of the space charge forces, the eigenmodes for the small beam oscillations are found in a straightforward way. The associated eigenfrequencies are the roots of a 3-diagonal determinant. The spectrum involves only real and discrete eigenfrequencies, and is similar to the spectrum of a beam with uniform density in real space or in phase space. (auth)

19113 PARAMETRIZATION OF LINEAR COUPLED MOTION IN PERIODIC SYSTEMS. Edwards, D. A.; Teng, L. C. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 885-888(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The Courant-Snyder parametrization for one-dimensional linear motion in periodic systems is generalized to two-dimensional coupled linear motions. The 10-parameter 4×4 symplectic trans-

fer matrix across a period is expressed in two normal-mode invariant phase-advances, four normal-mode periodic "amplitude" functions, and four periodic functions which reflect the strength and structure of the coupling. These parametric functions are also given by differential equations containing the periodic force coefficients appearing in the Hamiltonian. Two bilinear invariants can be constructed. With given horizontal and vertical aperture limitations, these invariants give the four-dimensional phase-space acceptance volume and the propagation of the horizontal and vertical emittances of the beam. The study was undertaken to compensate the coupling between radial and vertical betatron oscillations in the NAL Synchrotron. (auth)

19114 EFFECT OF RANDOM FLUCTUATIONS ON SYNCHROTRON PHASE MOTION. Snowdon, S. C. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 889-891(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A unified presentation is made of the growth of longitudinal phase area occupied by the beam due to random fluctuations of the magnetic field, radio frequency, and cavity voltage. The description is characterized by a linear treatment of the synchrotron motion, introduction of an envelope function similar to that used in betatron motion, and the use of Nyquist's theorem to obtain power spectra. Application is made to the NAL booster. (auth)

19115 PARAMETER STUDY OF THE INVISIBLE LONG STRAIGHT SECTION FOR SYNCHROTRONS. Meads, P. F. Jr. (William M. Broebeck and Associates, Berkeley, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 875-876(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A symmetric insertion containing an unusually long unobstructed drift space is described. A consequence of its identity transfer properties in the radial plane (2π betatron phase advance) and its transverse reflection properties in the vertical plane (π betatron phase advance) is its invisibility, neither disturbing the betatron oscillation in either plane for particles of synchronous energy nor disturbing the closed (equilibrium) orbit properties for particles of different energy. Because of the different phase advances in the two planes, the insertion can be designed so that all of its six quadrupole magnets lie at the extreme ends of the insertion. This leaves all of the drift space, excepting only that portion required for coil terminations, etc., in a single unobstructed drift space. A thorough parameter study with linear and aberration properties through third order is reported. (auth)

19116 BUNCHING OF INTENSE PROTON BEAMS WITH SIX DIMENSIONAL MATCHING TO THE LINAC ACCEPTANCE. Weiss, M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 877-879(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A method has been developed for the determination of bunching parameters in the frame of a six-dimensional beam-matching to the linac acceptance. In the absence of space charge, initial solutions for the buncher distance, voltage and efficiency, which satisfy the matching requirements, are found analytically or with ancillary computer programs. Then an iterative calculation is applied to solve the more general bunching problem in the presence of space charge. In the analysis, the beam is represented as an entity, described by the second momenta of particle coordinates and velocities. All the forces are linearized; the evolution of r.m.s. values depends primarily on the linear force component. (auth)

19117 CORRECTION OF INTENSITY-DEPENDENT BEAM LOSS IN THE NAL BOOSTER SYNCHROTRON. Hubbard, E. L.; Peters, R. E.; Ruggiero, A. G. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 863-865(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

At beam currents above 1.5×10^{11} protons/pulse in the 8-GeV booster synchrotron, part of the beam is lost during a time interval of 2 to 4 msec just before transition. Particles are lost from several of the 84 rf beam bunches while the number of particles in the other bunches does not change. Electromagnetic coupling between the betatron motion and the magnet laminations which are not shielded from the beam by a vacuum chamber may induce the head-to-tail effect and cause the loss. This effect is sensitive to the chromaticity, $\xi = (\Delta\nu/\nu)/(\Delta p/p)$. Changing the chromaticity with dc sextupole magnets at three locations in the ring has eliminated the loss for beam currents as high as 4.5×10^{11} protons/pulse. (auth)

19118 NEUTRALIZATION OF BUNCHED PROTON BEAMS. Schoenauer, H. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 866-868(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Electrons created by ionization of the residual gas can have initial velocities such that they survive several bunches and experience periodic focusing forces. Applying the AG synchrotron formalism to them shows the existence of regions of stable motion. In the frame of a linear theory one can expect partial neutralization for machines with only a few bunches above transition. (auth)

19119 STOCHASTICITY LIMIT AND TURBULENT MOTION OF PHASE-SPACE FLUID. Teng, L. C. (National Accelerator Lab., Batavia IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 843-846(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF 730310-.

An attempt to provide an alternative picture for visualizing the motion of a particle under the influence of non-linear forces based on the fact that for particles performing a Hamiltonian motion, the ensemble of their phase-points behaves like an incompressible fluid in the phase space is given. The program is stated: if we can cast the motion of the phase-fluid given by the canonical equations of a Hamiltonian in the form of the Navier-Stokes equation for a viscous and incompressible fluid we should expect that the Reynolds condition for the onset of turbulence will give the stochasticity limit. This is manifestly true since the Reynolds condition is a purely geometrico-statistical condition based on a mathematical similarity parameter and the transition to stochasticity, as well as to turbulence, is only a mathematical correlation phenomenon with no change in physical content. This program will bring the mathematics into a form for which the statistical correlation properties have been properly parametrized and thoroughly investigated. The case of one-dimensional motion only is treated. (WHK)

19120 BEAM DYNAMICS IN THE PRESENCE OF IONS AND ELECTRONS. Zotter, B. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 847-849(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The e−p (electron−proton) instability in proton accelerators is studied because of its possible implications on electron-ring accelerators. (WHK)

19121 LONGITUDINAL STABILITY CRITERION FOR BUNCHED BEAMS. Sacherer, F. J. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 825-829(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The unstable motion of a bunched beam consists of rigid-bunch (dipole) and higher bunch-shape oscillations of the individual bunches (individual-bunch modes), plus perhaps coupled motion of the different bunches (coupled-bunch modes). Stability is achieved either by decoupling the bunches or by a spread in synchrotron frequencies within a bunch. A stability criterion analogous to the Keil-Schnell criterion for coasting beams is given which includes the effect of a beam interacting with perfectly conducting walls, resistive walls, and resonant structures. Some examples for the CERN accelerators are included. (auth)

19122 CALCULATIONS ON HIGH FIELD MAGNETS WITH IRON YOKES AND RECTANGULAR COILS. Umstaetter, H. H. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 723-725(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Most studies on high-field bending magnets for superconducting synchrotrons or high energy beam transport in the last years concentrated on designs with a circular aperture and $\cos\theta$ current distribution which is approximated by blocks of windings of stepwise decreasing current density. An alternative solution consists in the design of a magnet with square or rhomb shaped aperture which has the property that rectangular coils with only 2 steps of current density represent its exact solution. There exist also solutions with the same current density in all coils. The multipole field distortions of this class of magnets are studied in order to find suitable shapes of the outer iron shield. (auth)

Storage Rings

19123 (RL-73-18, pp 134-159) EPIC EXPERIMENTS. Toner, W. T. 1973.

It is stated that EPIC is a proposal for an Electron Proton Intersecting Complex which could be built at a not impossible cost in a finite time. The range of parameters under consideration is summarized: possible stored beams; e^-: 8 to 14 GeV in a ring with conventional magnets; e^+: 8 to 14 GeV in a second ring with conventional magnets; p or D: 70 to 200 GeV/c in a ring with superconducting magnets: possible collisions at $S = 4\ E_1E_2$; e^+e^-, e^-e^-: 256 to 784 $(GeV)^2$; e^-p, e^+p: 2200 to 11,200 $(GeV)^2$; $e^-n(p)$, $e^+n(p)$: 1100 to 5600 $(GeV)^2$. Discussion falls under the following headings: general survey of physics, heavy leptons, could deep inelastic weak interactions be detected at EPIC? (UK)

19124 (UCID-16299) POSSIBLE COHERENT ELECTROMAGNETIC EFFECTS IN THE LOS ALAMOS PROTON STORAGE RING. Neil, V. K.; Cooper, R. K. (California Univ., Livermore. Lawrence Livermore Lab.). 4 Jun 1973. Contract W-7405-eng-48. 21p. Dep. NTIS $3.25.

A theoretical survey of coherent electromagnetic effects pertaining to the proposed Los Alamos proton storage ring is presented. The effects of the electromagnetic self-forces of the beam on both the incoherent and coherent motion of beam particles are evaluated. The calculations are based for the most part on existing theory. In some instances experimental observations in operating accelerator and storage rings are cited. For the design parameters of the ring, the calculations indicate that only the transverse coherent instability possibly may be troublesome, but may be suppressed by feedback. The design parameters of the ring that are pertinent to this work are shown in tabular form. (auth)

19125 TWO APPLICATIONS OF LEAKTIGHTNESS CONTROLS FOR LARGE ASSEMBLIES. Devallan, C.; Le Pavec, M.; Marcellin, J. (Societe Generale d'Etudes Mecaniques et Electriques, Bourg-les-Valence, France). Ind. At. Spatiales; 17: No. 1, 17-30 (Jan 1973). (In French and English).

Two applications of leaktightness controls are presented: application to the CERN intersecting storage rings at Geneva and application to the storage of liquid methane in a tank. The different assemblies led to the industrial development of two different control techniques, the first utilizing helium as the tracer gas and the second utilizing ammonia gas. The current use of leakage detection techniques in industry is discussed. (FR)

19126 UTILIZATION OF IONIZATION GAGES TO DETECT LEAKS. Benvenuti, C.; Decroux, J. C. (European Organization for Nuclear Research, Geneva). Vide; 27: No. 162, 243-248(Nov 1972). (In French).

A leak detection method applicable to the ISR (CERN) vacuum system after bakeout is presented. The method utilizes the change produced in an ionization gage by the injection of argon through a leak. A detection efficiency, which compares favorably with that obtained using classical detectors is achieved. The method has the advantage of being suitable for use after baking without risking the contamination of the system. (FR)

19127 EVALUATION OF SYNCHROTRON RADIATION INTEGRALS. Helm, R. H. (Stanford Univ., CA); Lee, M. J.; Morton, P. L.; Sands, M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 900-901(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Many of the important properties of the stored beam in an electron storage ring are determined by integrals, taken around the whole ring, of various characteristic functions of the guide field. Some of the integrals are handled easily, but a few are usually estimated graphically—particularly for alternating-gradient guide fields. A convenient method for evaluating numerically these recalcitrant integrals is described. (auth)

19128 HEAD-TAIL INSTABILITY. Paterson, J. M. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 850-851(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In the ACO and ADONE electron-positron storage rings, a transverse instability was observed whose characteristics could not be explained by the classical multiturn resistive-wall mechanism. This instability was independent of the betatron frequency and the threshold was a function of only the local current (i.e., number of particles in a bunch) not on the total circulating current. This prompted the development of a new theory, the head-tail theory, in which the head of a bunch drives the tail of the same bunch through some wake field, which need not be much longer than the bunch itself. Over the last several years the head-tail mechanism has been used successfully in explaining many of the characteristics of transverse instabilities observed both in storage rings and synchrotrons. There are, however, several important discrepancies between theory and observation which was discussed. (auth)

19129 HIGH-INTENSITY EFFECTS IN THE LONGITUDINAL MOTION OF STORED PARTICLE BEAMS. Seasler, A. M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 854-857(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A brief review is given of the various self-field phenomena associated with the longitudinal motion of particles in storage rings. (24 references) (auth)

19130 ARTIFICIAL BEAM ENLARGEMENT. Morton, P. L. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 862(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

It appears that the effective cross section of non-colliding beams can be enlarged in a controllable manner. However, at the present time the enlargement of cross sections of colliding beams has met with only meager success. Some of the possible difficulties in the cross-section enlargement of colliding beams are pointed out, but at the present moment it is not clear which, if any, of these difficulties is the real culprit. (WHK)

19131 EXPERIMENTAL INVESTIGATION OF THE COHERENT LONGITUDINAL INSTABILITY OF RELATIVISTIC PARTICLE BEAMS. Zotter, B.; Bramham, P. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 830-833(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In order to verify the theoretical predictions of stability of relativistic proton beams against coherent longitudinal oscillations driven by interaction with the surrounding vacuum chamber wall in the design of the ISR, a special high-Q cavity was built with remotely controlled tuning and damping. Already the first experiments with the cavity were successful, and the beam was driven unstable at thresholds quite close to those calculated for simplified models. These results also confer more credibility to the claim that it is necessary to continue the costly efforts of keeping the wall impedance low. (auth)

19132 MEASUREMENTS ON BEAM–BEAM INTERACTION AT SPEAR. Widemann, H. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 838-842 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Measurements of luminosity at SPEAR, which were performed at different operational conditions of the storage ring are shown and discussed. The parameters varied are: the current in both beams, the minimum betatron amplitude functions at the collision point, and the energy and the vertical betatron frequencies. As a result of these measurements it was found that the maximum achievable luminosity is much higher than predicted by the incoherent beam–beam limit using $\delta\nu = 0.025$. It was also found that the maximum achievable luminosity is a strong function of the betatron frequencies. After computing the largest linear tuneshifts, it was found that the quarter resonance seems to be the limiting effect for beam–beam collision. (auth)

19133 OPERATING RESULTS FROM ISR. Schnell, W. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 747-751(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The CERN Intersecting Storage Rings are now in routine operation for colliding-beam physics. In 1972 more than 75% of the total operating time was used for physics or preparation for physics runs. The machine's performance has increased substantially. The original design aim for luminosity has been reached and decay rates and background radiation with intense beams have been further reduced. Some operational aspects and the main performance limitations are described. (auth)

19134 OPERATING RESULTS FROM SPEAR. Richter, B. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 752-755(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Initial operating experience with the SLAC electron-positron storage ring SPEAR is described. A luminosity of 1.2×10^{31} cm^{-2} sec^{-1} has been achieved and two-beam interaction effects are described. A single-beam coherent instability, which can be suppressed either by control of the ring chromaticity or by feedback, has been observed. Current-dependent bunch lengthening and widening have been observed, and experiments indicate that these phenomena may be associated with an increase in the energy

spread of the beam. Procedures to increase the luminosity to the design value are discussed. Plans to increase the maximum beam energy of SPEAR to 4.5 GeV are described. (auth)

19135 STORAGE RING PROGRAM IN NOVOSIBIRSK. Skrinskii, A. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 756-759(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A brief history and schematic diagrams are given of the VEPP-1 VEPP-2, VEPP-2M, VEPP-3, and VEPP-4 storage rings. Machine parameters are discussed. (WHK)

19136 BEAM INDUCED GAS DESORPTION IN THE CERN INTERSECTING STORAGE RINGS. Groebner, O.; Calder, R. S. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 760-764(Jun 1973).

From 5th particle accelerator conferences; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The maximum beam intensity achieved in the ISR has been limited up to now by the beam induced pressure rise which builds up with the stacked proton current. This pressure increase can be explained by ion induced gas desorption from the vacuum chamber. The pressure P, as a function of the stacked proton current I, can be described in good approximation by $P = P_0/[1-(k\eta/S)I]$, where P_0 is the pressure without beam, S the pumping speed, η the net gas desorption coefficient in molecules per incident gas ion and k is a constant. This concept shows the existence of a critical current at which the pressure goes to infinity. The desorption coefficient depends on the primary ion energy, the type of ions and above all, on the surface conditions. Surface treatments yielding low and even negative values of η are discussed together with experimental results obtained. (auth)

19137 DEPENDENCE OF PHASE INSTABILITIES ON BUNCH LENGTH AT THE CEA. Averill, R.; Eddy, R.; Hofmann, A.; Little, R.; Mieras, H.; Nicholls, G.; Paterson, J. M.; Strauch, K.; Voss, G. A.; Winick, H. (Harvard Univ., Cambridge, MA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 765-767(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Betatron and phase instabilities have been observed at the CEA during multicycle filling and dc storage. The betatron instabilities are caused by the head-tail effect and have been controlled with sextupoles which make the chromaticity zero or slightly positive. The phase instability at present limits the electron and positron current which can be accumulated. Measurements of the threshold currents required to observe the onset of phase instabilities were made. These measurements show: (a) The threshold current required to observe the onset of this phase instability is independent of the number of bunches down even to one bunch. (b) The threshold current for the onset of this instability first decreases with increasing bunch length, goes through a minimum, then increases again for long bunch length. A cavity operating at the third harmonic of the main accelerating system frequency, thus providing increased nonlinearity of the total rf voltage waveform (hence increasing the Landau damping), increased the threshold current for the onset of these instabilities. (auth)

19138 (BEAM DYNAMICS ON ACO. Buon, J.; Chehab, R.; Jejcic, A.; Le Duff, J.; Level, M. P.; Martin, P.; Nguyen Ngoc, C.; Petit, H.; Potaux, D.; Sommer, M.; Zyngier, H. (Paris Univ., Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS 20: No. 3, 768-772(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

After a shut down of several months during which some improvements were made on ACO such as a computer control of the power supplies, and a new detector for high energy experiments was installed, an extensive beam experiment program was started. This mainly concerned the beam-beam effect with and without small beam separation at the crossing point, the cure of transverse instabilities with new sextupolar coils placed inside the quadrupoles, the check of power supplies stabilizations by means of the synchrotron frequencies, and the development of a new ACO structure with low β's. During the same period new measurements of the neutral modes of the ϕ_0 were started on ACO. Finally a beam of synchrotron light extending up to 10 Å will soon be put in operation for molecular, atomic, and solid state physics. The typical luminosity at 510 MeV is now about $3.4.10^{32}$ $cm^{-2} \cdot h^{-1}$ with 35 mA in each beam, and this new improvement seems to be related to a better power supplies stabilization. (auth)

19139 CREATION OF SMALL INTERACTION DIAMONDS IN THE CERN INTERSECTING STORAGE RINGS (ISR). Bryant, P. J. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 773-776(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The original ISR design included the possibility of superposing equilibrium orbits in four of the eight intersection regions by means of supplementary quadrupoles. This scheme has two advantages. Firstly, the beam density is increased so improving the ratio of beam-beam to beam-gas counts and secondly, the size of the interaction diamond is greatly reduced. The closed orbit modulation was measured and the effects of this scheme on the betatron frequencies was studied. Since the scheme is applied with the stacks already circulating, dynamic computer control of the correcting elements is required to maintain the correct tuning in the ISR. In total, 31 power supplies are progressively changed. Since the machine is strongly perturbed by this scheme, nearly all aspects of operation are affected. This particularity applies to the excitation of localized bumps in the closed orbits. Fully satisfactory operation for physics experiments has been achieved with beams of typically 6 A, a luminosity of 1.4×10^{30} $cm^{-2}s^{-1}$ and a diamond size corresponding to a single injected pulse. (auth)

19140 PROPOSED DESY PROTON–ELECTRON COLLIDING BEAM EXPERIMENT. Febel, A.; Gerke, H.; Tigner, M.; Wiedemann, H.; Wiik, B. H. (DESY, Hamburg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 782-785(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

It is proposed to store protons as well as electrons and positrons in the DESY storage ring, DORIS. The techniques planned for accomplishing this and the hoped for results are described. (auth)

19141 MEASUREMENTS OF STACKING EFFICIENCY IN THE CERN INTERSECTING STORAGE RINGS (ISR). de Jonge, M. J.; Messerschmid, E. W. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 796-798(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The efficiency of the stacking process, in which protons are accumulated into longitudinal phase space by means of a radio frequency (RF) voltage, was measured as function of different parameters such as energy, RF voltage, number of stacking cycles and $\Gamma = \sin \Phi_s$, where Φ_s is the relative phase of protons in synchronism with the RF voltage. The efficiency was found to depend predominantly on Γ and the number n of stacking cycles. Efficiencies higher than 70% were measured for values of $\Gamma \leq 0.5$ and $n \geq 30$ for both the repetitive and the nonrepetitive stacking scheme. The agreement between theoretical predicted efficiencies, obtained from a computer simulation of the stacking process, and the measured efficiencies is very good for higher values of n. From both the theoretical calculations and the measurements a rule of thumb could be derived which gives a good approximation of the stacking efficiency far above transition energy as function of Γ and n. (auth)

19142 IMPROVEMENT IN LUMINOSITY, BACKGROUND AND CHAMBER PROTECTION WITH BEAM SCRAPERS IN THE ISR. Bryant, P.; Huebner, K.; Johnsen, K.; Laeger, H.; Montague, B.; Neet, D.; Schneider, F. W.; Turner, S. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 799-801(Jun 1973).

From 5th particle accelerator conference; San Franciso, California, USA (5 Mar 1973). See CONF-730310-.

The Intersecting Storage Rings (ISR) are equipped with beam scrapers used for various purposes such as improving luminosity, reducing background, beam diagnostics and for protection of machine components. A description is given of the different types of scrapers and of the results in the various applications obtained during the last year. In particular, the substantial improvements in luminosity and background by scraping are described. (auth)

19143 MEASUREMENT AND COMPENSATION OF SPACE CHARGE INDUCED Q-SHIFTS IN THE CERN INTERSECTING STORAGE RINGS (ISR). Autin, B.; Gourber, J. P.; Laeger, H.; Thorndahl, L. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 802-804(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The space charge induced Q-shifts were measured either by comparing the radial positions of a given nonlinear resonance with and without a stack, or by means of RF deflecting fields. The first consequence of these Q-shifts is a displacement of the working line in the stability diagram towards low order non-linear resonances. A secondary effect is a progressive reduction of the

radial derivatives of the Q's at the edges of the stack with increasing intensity, which makes the stack unstable in these regions. These results were used to derive "prestressed" working lines which are suited to high intensity stacks. (auth)

19144 EXTENSION OF THE CERN ISR ENERGY BY ACCELERATION OF STACKED BEAMS. Hansen, S.; Henrichsen, K. N.; de Jonge, M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 805-806(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The proton beams in the CERN Intersecting Storage Rings (ISR) have been accelerated to achieve colliding beams at 31.4 GeV/c, equivalent to a momentum of above 2000 GeV/c if a conventional accelerator with a stationary target were used. High density stacks were made at 26.5 GeV/c from which a part was rebunched with the maximum available RF voltage. The rebunched beam was kept near central orbit while the magnetic field was gradually increased to its maximum value. The major problem was to keep the betatron oscillation frequencies unchanged while changing the magnetic field thus avoiding any blow-up of the beam due to resonances. The corrections of the highly non-linear saturation effects of the main magnet were achieved by a computer controlled tuning of the field by excitation of the poleface windings and sextupole lenses. Closed orbit corrections were applied throughout the acceleration. Colliding beams with currents above 0.5 A were obtained. (auth)

19145 TRANSVERSE FEEDBACK FOR THE ISR. Thorndahl, L.; Vaughan, A. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 807-808(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A feedback system designed to assist Landau damping against resistive wall instabilities in the vertical and horizontal planes is described. The purpose of the feedback system is to make it possible to run the ISR with reduced Q-spread, so that low order resonances can be avoided at high intensities. An important problem in the system is the electronic noise of the amplifiers which can cause excessive long-term vertical beam blow-up if the bandwidth is too large. Only four transverse modes are included in the loop. (auth)

19146 USE OF THE ISR FOR EXPERIMENTS. Couchman, B. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 809-812(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The layout of the ISR is discussed showing the situation of the six intersections presently used for physics experimentation. A brief discussion of some of the physics equipment installed is included. A description of an intersection region is given showing the space available and the constraints imposed by the vacuum chamber. The use of the machine for physics is discussed, the measurement of the luminosity at all the intersections, minimization of background etc., the ISR control computer playing a large part in these operations. A section describing the so-called Split Field Magnet facility is included. (auth)

19147 PERFORMANCE OF THE CEA AS AN e^+e^- STORAGE RING. Averill, R.; Colby, W. F.; Dickinson, T. S.; Hofmann, A.; Little, R.; Maddox, B. J.; Mieras, H.; Paterson, J. M.; Strauch, K.; Voss, G. A.; Winick, H. (Harvard Univ., Cambridge, MA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 813-815(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The Cambridge Electron Accelerator (CEA) has been devoted solely to electron-positron colliding-beam physics since 1970. By early 1972 an operational system had been developed with a peak luminosity of 2×10^{28} cm^{-2} sec^{-1}. An experiment observing e^+e^-, $\gamma\gamma$, $\mu^+\mu^-$, and hadron events was then completed at a beam energy of 2 + 2 GeV and an integrated luminosity of 1.12×10^{34} cm^{-2}. Since then, many improvements have been made to increase the average luminosity and to permit operation at higher energy. A cryogenic pumping system has been installed close to the interaction region resulting in a significant pressure drop and reduction in background in the luminosity counters. A final experiment is now in progress at a center-of-mass energy of 2.5 + 2.5 GeV, after which the colliding beam physics program will be terminated because higher luminosity is available from the Stanford storage ring SPEAR. (auth)

19148 LIMITATION IN SHORT BUNCHES PRODUCTION WITHIN ELECTRON STORAGE RINGS. Bruck, H.; Bardin, J. P.; Gournay, J. F.; Laclare, J. L.; Leleux, G. (CEN, Saclay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 822-824(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Short bunches are required in electron storage rings. To get them shorter one is tempted to have machines working near transition energy. Then it becomes necessary to watch out for nonlinear terms because lower synchrotron and betatron stability limits arise. Typical results are given. (auth)

19149 POSITION AND INTENSITY MONITORING SYSTEM FOR THE SPEAR TRANSPORT SYSTEM AT SLAC. Chang, A. K.; Kang, H. K.; Larsen, R. S. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS 20: No. 3, 624-630 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A brief description of the stripline position and intensity monitor for the SPEAR transport system is presented. The basic objective of this system is to visually display on an oscilloscope the current and position information of a 7 ns positron/electron beam of very low duty cycle (10 to 20 pps). The system incorporates and uses much of the video system at the Main Control Center (MCC) which was designed to display video pulses of 1.6 μs width. In order to maintain compatibility with this system, the detected signals from the stripline monitors, which are 7 ns bipolar signals, are transformed into stretched signals of the order of 1 μs, the amplitude and polarity of which reflect those of the original signals. System functions and the associated electronics are described in detail. (auth)

19150 MONITORING THE BEAMS IN SPEAR WITH SYNCHROTRON LIGHT. Sabersky, A. P. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS 20: No. 3, 638-641(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Bringing the synchrotron light out of the ring, mirror deformations, mirror and window, alignment, television and scanner system, optical beam splitters (pellicles), the television system, the scanning system, bunch length measurement, and photometric measurements are discussed. (WHK)

19151 AUTOMATIC CONTROL PROGRAM FOR SPEAR. Boyarski, A. M.; King, A. S.; Lee, M. J.; Rees, J. R.; Spencer, N. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 580-583(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In the operation of SPEAR, it is necessary to change the configuration (defined by the betatron numbers ν_x, ν_y, the beam energy E, and the beta functions β_x^*, β_y^*, and eta function η^* in the interaction regions) from one operating point to another without losing the stored beams. For example, filling the ring is done at one configuration, while experiments may require another which has different energy, η^*, β^*, and ν in order to obtain the desired luminosity. This is accomplished by controlling the set points of the magnet power supply regulators by means of a control computer. Salient features of the hardware, the controlling computer, and its software to make such changes possible are described. SPEAR has been operated successfully under computer control using the code RING. Some results of its operation are presented. (auth)

19152 SLAC STORAGE RING BEAM TRANSPORT INSTRUMENTATION AND OPERATION. Huang, T. V.; Tsang, D. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 451-454(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Accelerator beam transport system instrumentation, and operation in general, is a matter of routine engineering. Given sufficient funds and space, an optimum design with maximum effective human interface usually prevails. However, given a very low budget and the criteria that the alternately injected e^-, e^+ beam be run simultaneously with a minimum of six other primary beams, a deviation from standard design practice and operation philosophy was required. The requirements necessary to bring the alternate e^- or e^+ began through the 400 meter long beam transport system with an initial common bend of 48° then a separate bend of 12° each for each of the electron and positron beam paths are described. The approach to effectively fulfill the operation requirements was a coherent mixture of adding controls to existing similar function panels and a multitask operation chassis. This multitask chassis contains different but interrelated functions in a single panel. The operation of this multitask panel is also operable from the distant and separate SPEAR control room. The deviation of general engineering practices resulted in an optimum performance per cost balance. (auth)

Experimental Facilities

Refer also to abstract 18370.

19153 (LA-5306-MS) RADIATION-HARDENED MAGNETS USING MINERAL-INSULATED CONDUCTORS. Harvey, A. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 17p. Dep. NTIS $4.00.

A unique feature of the LAMPF high-intensity linac experimental area is the extensive use of inorganic magnet coils to withstand the high radiation doses expected. In a large number of these magnets the coil insulation is compacted magnesium oxide powder ("mineral insulation," m.i.) and pre-insulated cable is wound into the required coil configuration. Although the cable itself is expensive compared to bare copper conductor, the finished coil cost is comparable to a conventional coil, since no insulation application is required of the coil winder. Two conductor formats are used at LAMPF: solid conductor, externally cooled, using soft solder to improve the heat transfer within the coil; and directly cooled, hollow conductor m.i. cable. At LAMPF both conductor types are conservatively rated. Indirectly cooled coils are used exclusively in the switchyard magnets, where low field strengths and high quality are required. Higher-power magnets for target-to-target transport and secondary beam lines use direct cooling. Methods of making terminations on the cable are described. Measured operating parameters for all these magnets are tabulated. Pole-shaping techniques for the bending magnets and quadrupoles are examined and the results given. (auth)

19154 (LA-UR-73-655) STATUS OF THE LOS ALAMOS MESON PHYSICS FACILITY FOR RADIONUCLIDE PRODUCTION. O'Brien, H. A. Jr. (Los Alamos Scientific Lab., N. Mex.). [nd]. 19p. (CONF-730542-1). Dep. NTIS $3.00.

From dedication symposium; Cincinnati, Ohio, USA (4 May 1973).

The layout of the Los Alamos Meson Physics Facility is given, and, particularly, the Isotope Production Facility is described. Data obtained using the 600-MeV proton synchrocyclotron at the Space Radiation Effects Laboratory on thin target proton-induced spallation cross sections are being used for estimating isotope yields at LAMPF. A sampling of estimated isotope yields is given. (WHK)

19155 (LA-UR-73-1000) NEWLY DEVELOPED IRRADIATION FACILITY AT LAMPF. Dudziak, D. J.; Green, W. V.; Regenie, T. R.; Zukas, E. G. (Los Alamos Scientific Lab., N. Mex.). [nd]. 12p. (CONF-730910-6). Dep. NTIS $3.00.

From international conference on irradiation experimentation in fast reactors; Jackson Hole, Wyoming, USA (10 Sep 1973).

LAMPF is a National Facility designed, built and operated for the USAEC by the Los Alamos Scientific Laboratory. It is a linear proton accelerator designed primarily as a meson factory, but includes a neutron radiation effects facility. This presentation describes how LAMPF has been developed as a neutron irradiation damage facility, and informs potential users about the facilities available for their experiments. (auth)

19156 QUALITY OF RADIATION FROM THE BETATRON OF TAMPERE CENTRAL HOSPITAL. Brenner, M. pp 86-87 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

Characteristics of the bremsstrahlung beam from the B5M-25 betatron at the Pikonlinna radiotherapy clinic are discussed. Focusing field, accelerator tube, and filter alignment are discussed. The intensity distribution of the bremsstrahlung beam is plotted. (WHK)

19157 PRODUCTION AND USE OF FAST NEUTRONS IN BIOLOGICAL RESEARCH. Holmberg, P.; Vaenskae, R. (Univ. of Oulu, Finland). pp 112-114 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

A brief review of the methods of producing fast neutrons is given together with some methods of collimation and shielding of neutron beams. The application of fast neutrons to activation analysis and radiotherapy is discussed. (auth)

19158 FIRST MEASUREMENTS OF THE ELECTROMAGNETIC RADIATION OF THE 140-MeV ELECTRON SYNCHROTRON OF THE PTB. Kaase, H. PTB Mitt.; 83: No. 1, 9-12 (1973). (In German).

The spatial distribution of the electromagnetic radiation of the 140 MeV electron synchrotron of the PTB (Physikalisch-Technische Bundesanstalt, Brunswick, F. R. Germany) is analyzed, considering the polarization and the dependence on the electron energy. Some applications of the synchrotron radiation are also discussed. (GE)

19159 DIELECTRIC-LINED CIRCULAR DEFLECTORS FOR ULTRAHIGH-ENERGY BEAM SEPARATORS. Chang, C. T. M. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 133-135(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Circular deflectors lined with boron nitride, beryllia, and alumina are studied for application to ultrahigh-energy beam separators. These deflectors are designed at an aperture of 1 cm^2 at 5.6 and 8.5 GHz. The attenuation length, transverse shunt impedance, and group velocity are presented in graphs. (auth)

19160 USE OF USSR PROTON ACCELERATORS FOR MEDICAL PURPOSES. Dzhelepov, V. P. (Joint Inst. for Nuclear Research, LNR, Dubna, USSR); Savchenko, O. V.; Komarov, V. I.; Abasov, M.; Goldin, L. L.; Onossovsky, K. K.; Khoroshkov, V. S.; Lomanov, M. F.; Blokhin, N. N.; Ruderman, A. I.; Astrakhan, B. V.; Vajnberg, M. S.; Minkova, E. I.; Kisileva, V. N. IEEE (Inst. Elec. Electron, Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 268-270(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The uses of proton beams at the JINR Dubna synchrocyclotron and the ITEP synchrotron for medical and biological purposes since 1967 are reviewed. 58 patients have been treated at JINR and 163 at ITEP. Proposed and existing facilities are briefly discussed. (WDK)

19161 INTERCOMPUTER COMMUNICATIONS IN REAL TIME CONTROL SYSTEMS. Smith, S. R.; Goodwin, R. W.; Storm, M. R. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 536-540(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Considerations of bandwidth, noise, distance, response time, data and system integrity, maintenance, interfacing, software control, data organization, cost, and development time complicate the implementation of intercomputer links in real time control and data acquisition systems. This paper tells how to do it. The NAL link provides an example. (auth)

19162 CAMAC EXPERIMENTAL BEAM LINE CONTROL SYSTEM. Hepinstall, L. J.; Barsotti, E. J.; Lau, H. C. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 514-517(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The laboratory has well over two miles of beam lines in the Meson, Neutrino, and Proton experimental areas. The size and complexity of these beam lines as well as the requirements imposed by multiple experimenters led to the development of a computer-controlled multi-console control system. To alleviate many of the problems associated with interfacing various experimenters' equipment to this control system, a well-defined hardware interface was necessary. A CAMAC modular instrumentation system was employed in all three beam lines primarily because it is an international standard. Each of the beam lines is computer controlled using a number of CAMAC crates located in control areas scattered along each beam line. These control areas are tied together and to the computer by a fast serial communications link. Control consoles consisting of CRTs or teletypes are interfaced to CAMAC crates and may be located in any control area. The system software handles up to 12 of these remote consoles, 2 local consoles, and a variety of other tasks simultaneously through a multi-programming technique. Man-machine communication is by means of custom CRT displays and a message-oriented command language. (auth)

19163 OPERATIONAL ASPECTS OF THE SLAC MAIN CONTROL CENTER. Crook, K.; Huang, T. V.; Nelson, G.; Price, V. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 510-513(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The SLAC Main Control Center (MCC) incorporates functions that were previously handled in two separate control rooms; i.e., (1) the setup and maintenance of interlaced beams in the accelerator and (2) the delivery of the beams to separate experimental areas. The complexity of beam operation has increased with the

activation of the new SPEAR facility. This experimental area uses low energy electrons and positrons which run simultaneously with a full complement of six other beams. Considering all the operational requirements, the MCC instrumentation plays a major role in determining the operation efficiency. (auth)

19164 NAL COMPUTER CONTROL SYSTEM. Daniels, R. E.; Goodwin, R. W.; Storm, M. R. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 505-509(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Equipment associated with the accelerator and experimental areas at the National Accelerator Laboratory is distributed throughout some ten miles of beam paths. The computer control system, which utilizes fifteen interconnected computers to control and monitor this equipment, is described. The clock, closed-circuit television, beam abort, and fire and utility monitoring systems are also reviewed. (auth)

19165 TUNING AND OPERATION OF THE EXTERNAL PROTON BEAM LINES OF THE ZERO GRADIENT SYNCHROTRON (ZGS). Wehrle, R. B.; Cho, Y.; Nielsen, R. W.; Creer, A. J.; Concaildi, G. A.; George, R. D. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 496-498(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Topics include the present configuration of the EPB (external proton beam) lines, EPB diagnostics, EPB control console, computed tunes, some features of EPB tuning and operation, and the radiation safety system for EPB-I and EPB-II. (WHK)

19166 BEAM HANDLING OF THE UNIVERSITY OF MARYLAND CYCLOTRON. Berg, R. E.; Johnson, W. P. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 481-482(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The University of Maryland cyclotron now produces the following beams on a regular basis: $E(^1H^+) \leq 100$ MeV, $E(^2H^+) \leq 82$ MeV, $E(^3He^{+2}) \leq 200$ MeV, $E(^4He^{+2}) \leq 165$ MeV. Uses of these beams and properties of the beam transport system for the various experimental areas are surveyed, and results of beam studies presented. Problems now under consideration are briefly discussed. (auth)

19167 300 GeV HIGH QUALITY ELECTRON AND PION BEAM AT THE NEW GENERATION PROTON ACCELERATORS. Guiragossian, Z. G. T.; Rand, R. E. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 483-487(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

It is demonstrated that high quality secondary electron beams can be made available with intensities of 10^8 e/pulse at the new generation proton accelerators. A beam design is presented with the following qualities. (1) Large beam transport acceptance [9.5 μster % Δp/p (FW), with a momentum bite of ±2%]; (2) good momentum resolution [less than ±0.3%]; (3) good angular resolution [less than ±0.1 mrad]; (4) small final spot size [less than ±3 mm horizontally and ±6 mm vertically]; and (5) negligible pion contamination [less than 1 pion in 10^5 electrons]. All of these qualities are achieved while preserving the valuable electron intensities at production. Using standard beam transport magnets a 300 GeV/c transport system is designed with four focussing stages, the first two of which provide a beam spot of sufficient quality for tagged photon experiments. The optics design is based on a periodic cell structure which includes correction of second order aberrations by means of four weak sextupoles. The synchrotron radiation by electrons throughout the transport system is used to advantage to remove pion contamination at the final beam spot. Pion impurity is null at energies greater than 160 GeV. This high quality transport system can also be used to deliver a high intensity pion beam [10^9 to 10^{10} π^- per 10^{13} interacting protons], up to 300 GeV/c. Thus a very versatile facility can be provided for electron and pion experiments at the same installation. A beam design specifically made for application at NAL is presented. (auth)

19168 PRODUCTION OF A HIGH ENERGY, HIGH POWER POLARIZED PHOTON BEAM AT SLAC. Eisele, R. L. (Stanford Univ., CA); Sherden, D. J.; Siemann, R. H.; Sinclair, C. K.; Quinn, D. J.; Rutherfoord, J. P.; Shupe, M. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 447-450(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Attenuation by coherent pair production in highly oriented compression annealed pyrolytic graphite has been used to polarize a 16 GeV bremsstrahlung beam. Graphite pieces of total volume $0.95 \times 0.95 \times 5.1$ cm^3 were assembled in water-cooled precision holders. Eighteen of these units were mounted in two independent coaxial assemblies. Each assembly provided precision angular orientation with respect to the beam direction, rotation of the graphite by 90° about the beam axis to rotate the plane of polarization, and removal from or insertion into the beam. One assembly, with 61 cm of graphite, served as a polarizer; the other, with 30.5 cm of graphite, was used as an analyzer. The complete device was placed between collimators in a sweeping magnet. Polarization of the attenuated beam, measured with SLAC pair spectrometer, was 0.255 ± 0.020. This number, and the measured spectrum, are in qualitative accord with the calculations. The beam has yielded intensities greater than 4×10^8 equivalent quanta per pulse, and has been used in an experiment to measure asymmetries in pseudoscalar meson photoproduction. (auth)

19169 NAL BEAM SPLITTING SYSTEM. Oleksiuk, L. W.; Andrews, R. A.; Blesser, E. J.; Rode, C. H. (National Accelerator Lab., Batavia, IL.) IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 428-433(Jun 1973).

From fifth particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The proton beam extracted from the National Accelerator Laboratory main ring synchrotron is transported through a magnetic switchyard that is designed to carry the external beam to three experimental area targeting stations located 3500 to 5000 ft. from the synchrotron extraction point. Two beam splitting facilities have been recently installed in the switchyard transport system so that all three experimental areas can receive beam simultaneously. (auth)

19170 SYNCHROTRON RADIATION AT THE CAMBRIDGE ELECTRON ACCELERATOR. Winick, H. (Harvard Univ., Cambridge, MA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 984-988(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

The basic features of synchrotron radiation with particular reference to the CEA, its enhancement by the use of wiggler magnets, the present performance and future capability of the CEA in storage and cycling modes of operation, special pulsing and modulation techniques, the features of the present beam run, and plans for future beam runs and shielding to permit occupancy of the target area are discussed. (WHK)

19171 PICOSECOND TIME MEASUREMENTS WITH A LINEAR ACCELERATOR AND RF SEPARATOR. Guiragossian, Z. G. T. (Stanford Univ., CA); Rothbart, G.; Yearian, M. R.; Gearhart, R.; Murray, J. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 994-996(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A picosecond time measurement method is described based on the microwave properties of beams from electron linear accelerators or from possible remodulated external proton beams at proton synchrotrons. A conventional RF separator (RFS) is used operating at the same frequency as the microwave structure of beams and driven by the same master oscillator which modulates the beam. For example, the 2856 MHz microwave at SLAC corresponds to 350 psec between beam RF buckets; accelerated electrons with an RF phase bite of about 5° are time structured and correspondingly have about 5 psec time spread in every 350 psec interval. Charged particles produced in interactions or decays originate with this time structure. An RFS is placed at the last stage of a double focusing spectrometer, providing a lever arm between it and the final (few mm) small spot size focus. Reference calibration charged particles are timed by setting the RFS relative phase to null deflections. Other observed particle arriving at different times than this standard are deflected a few tenths of a mm per psec of delay. A multi-wire proportional chamber (MWPC) having a 0.05 mm space resolution can provide time measurements with sub-picosecond resolution. The technique is used in an experiment to search for changes in the velocity of light with high energy photons at SLAC. The devised timing method is presented and the properties of a new, fine space resolution MWPC is demonstrated. (auth)

19172 SMALL ACCELERATORS FOR STUDIES IN THE APPLICATION OF NEUTRONS IN BIOMEDICINE. Bull, S. R. (Univ. of Missouri, Columbia); Hoft, R. H.; Slaten, N.; Thomson, J. M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 1002-1006(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A small accelerator which produces high energy (14.7 MeV) neu-

trons by the $^{3}H(^{2}H,n)^{4}He$ reaction has been utilized for two basic biomedical studies. First, fast neutron radiography has been explored as a technique for imaging biological objects. The primary objective was to test the sensitivity of the technique by measuring the differential attenuation coefficient necessary for object identification as a function of the sample thickness. Second, fast neutron radiotherapy experiments were undertaken. Animals with induced brain tumors were treated to observe the relationship between dose fractionation and cell repair. The results are encouraging and indicate the feasibility of further studies with a small accelerator. (auth)

19173 60 kW ELECTRON ACCELERATOR FOR A PAINT-CURING FACILITY. Reinhold, G.; Gleyvod, R.; Freiberg, E. (Emile Haefely and Co. Ltd., Basel). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 1015-1017(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Compared with radioactive isotopes, electron accelerators are very powerful sources of radiation. Due to the limited penetration depth of the electrons, these accelerators can only be applied for the radiation processing of surfaces or thin materials. Of special interest is the utilization of low-energy, high-power electron accelerators for the curing of paint coatings on wood, metal, and plastic surfaces. A paint-curing facility was built with a 600 keV electron accelerator with an output power of 60 kW. During the first year of continuous operation, important improvements were made in the entire process, particularly in developing suitable paint and maintaining a pure nitrogen atmosphere in the radiation chamber. (auth)

19174 RACETRACK MICROTRON AS A NEGATIVE PION SOURCE FOR RADIOTHERAPY. Wilson, P. B. (Stanford Univ., CA); Numan, C. S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 1018-1021(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Should clinical trials indicate that negative pion therapy is an improvement over present radiotherapy techniques, reliable pion sources of acceptable cost and size will be required at a number of major medical centers. A 300 KW, 500 MeV electron racetrack microtron is proposed which employs conventional accelerator guides and which can meet hospital requirements on cost, space and operational reliability. Coupling this machine to multi-channel pion applicators, a dose of 100 rads can be delivered in 5 to 10 minutes to a tumor treatment volume of 1000 cc, permitting treatment of 1000 cancer patients per year per machine. (auth)

19175 ELECTRON BEAM FLATTENING WITH AN ANNULAR SCATTERING FOIL. Sandberg, G. (Michael Reese Hospital and Medical Center, Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 1025-1026(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A narrow parallel beam of electrons from an accelerator is commonly spread over a useful area by multiple scattering in a thin foil for applications such as radiation therapy and bubble chamber experiments. If the intensity at the edge of the resulting useful field is a fraction x of that in the center, then only the fraction 1-x of the incident beam is used. A secondary scattering foil which intercepts electrons outside the useful field redirects some of these into a distribution which complements that from the primary scatterer, allowing the use of a thinner primary scatterer. The resulting distribution function is developed, in a small-angle approximation, and integrated for annular secondary scatterer elements as a double series which is evaluated by a computer program in terms of the thickness and dimensions of the annulus. Results are discussed and limits of applicability of the theory are pointed out. (auth)

19176 NEGATIVE PION BEAM TRANSPORT CHANNEL FOR RADIOBIOLOGY AND RADIATION THERAPY AT TRIUMF. Harrison, R. W. (British Columbia Cancer Inst., Vancouver. B. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 1029-1031(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A five quadrupole, two bending magnet negative pion beam transport channel has been designed to deliver a physical dose of 0.2 rad/sec into a volume of 10 cm × 10 cm × 8 cm thick located at a mean depth of 24 cm. The dose as a function of depth will be varied by a momentum-defining slit which will travel during the irradiation; a second slit in the system will be used to give a sharp lateral cut-off in the dose. Beam size will be varied appropriately choosing the distances from the second bend to the last quadrupole and from the last quadrupole to the irradiation location. The changes in beam properties due to second-order terms and their correction by sextupole magnets and pole edge curvatures are described. (auth)

19177 RADIOTRACER MEASUREMENTS OF SPUTTERED CONTAMINATION INCURRED DURING ION IMPLANTATION PROCESSING. Masters, B. J. (IBM System Products Div., Hopewell Junction, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 1032-1034(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Radioactive tracer measurements have been performed in order to establish limits for the degree of sputtered contamination to be expected during implantation processing in stainless steel target chambers. The information collected provides a useful set of working curves for the particular wafer-holding arrangement employed, and is presented in a form that should be convenient for use in the design of other stainless steel target-holder geometries. (auth)

19178 RESEARCH USING SYNCHROTRON RADIATION. Rowe, E. M. (Univ. of Wisconsin, Stoughton). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 973-979(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

In a period of less than ten years, the use of synchrotron radiation in the study of the optical and electronic properties of solids, liquids, and gases has developed from a laboratory curiosity into a widely exploited technique applicable to the needs of investigators working in physics, chemistry, and biology. The history, present state, and future development of this phenomenon in far ultraviolet and soft x-ray research are discussed. Synchrotron radiation groups and planned synchrotron facilities are discussed. (auth)

19179 OPERATING CHARACTERISTICS OF ARGONNE'S 50 μs RF PARTICLE SEPARATOR BEAM. Moretti, A. (Argonne National Lab., IL); Dawson, J. W.; Musgrave, B.; Wangler, T. P.; Yuta, H.; Ammor, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 949-951(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An rf separated beam line, beam 10, for the 12-ft bubble chamber has been constructed at Argonne's ZGS Complex. It utilizes two copper S-band rf deflecting structures, currently separated by a drift length of 31.25 m. The structures are excited from a central high-power rf modulator station, which can provide up to 10 MW of 50 μs pulsed rf power to each structure. The beam is instrumented with proportional wire chambers and scintillation counters. The first use of this beam was in taking 100,000 pictures in the 12-ft bubble chamber of 7.14 GeV/c protons where the rejected π^{+} contamination was 7%. Currently, tuning studies to provide a separated K^{-} beam at 6.52 GeV/c are taking place. Some pictures of interesting K^{-} interactions in the 12-ft chamber are included. A unique feature of this beam is the use of a fast rf diode switch to turn off the low power rf drive and, consequently, stop the beam when a maximum number of tracks (typically about 10) have entered the chamber. This feature has resulted in an improvement of the picture taking rate of the chamber by 30% for the 7.14 GeV/c proton run. (auth)

19180 PULSED BEAM SHUTTER FOR RADIO-FREQUENCY SEPARATED BEAMS AT THE ZGS. Praeg, W. F. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 737-739(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A pulsed beam shutter magnet is required to deflect a beam of separated high energy particles into a beam stop after a desired number of particles have reached the 12-ft bubble chamber at the ZGS. The magnet has a core, wound from 2 mil grain-oriented steel, an aperture 15 cm × 15 cm, and a $\int Bdl = 1$ kGm. The pulse has a risetime of ≤3 μs and a flattop of 40 μs. The above is achieved by discharging a high voltage capacitor bank into the magnet inductance, followed by a power-crowbar. The design of the magnet and the switching circuits is described and formulas for calculating the pulse shapes are given. Graphs of calculated flattops to 500 μs are shown. (auth)

19181 SEPTUM MAGNETS FOR SECONDARY BEAMS AT NAL. Carrigan, R. Jr.; Jagger, J.; Michelassi, G.; Pretzl, K.; Satti, J.; Snowdon, S.; Wehmann, A. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 719-722(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Septum magnets have been built for the front ends of secondary beam lines M1 and M6 in the Meson Area. The septum sizes are

1.742 in. (1.248 in.) for the M1 (M6) magnet. Field quality is reasonably good, as measured, although not as good as the design goals of 0.3% (0.1%) for M1 (M6). (auth)

19182 DESIGN OF SEXTUPOLE MAGNET FOR 200 GeV LINE. Statti, J. A.; Snowdon, S. C. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 713-715(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Sextupole magnets of 4 inch aperture, 2 kG/in^2 strength have been designed for use in the NAL Meson Area beam line. Pole shapes have been determined by conformal mapping to give continuous contours which are approximated by short straight line segments to facilitate machining. The resulting field quality is within 0.17 percent of a pure sextupole over a 3 inch "Good Field Width." The excitation is provided by a monolithic coil on each pole wound from 0.230 inch solid square copper. Four water-cooled flattened tubes provide heat sinks for conduction cooling with a maximum temperature rise of 20°C in the winding. Magnetic field measurements are presented. (auth)

19183 HIGH FIELD PULSED MAGNETS FOR A BUBBLE CHAMBER BEAM. Elliott, R. T.; Flower, P. S. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 698-702(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

To facilitate the production of hyperon-enriched beams for bubble chamber experiments, a range of pulsed magnets has been developed, featuring 20 to 40 cm-long bending magnets with peak fields up to 13 T, and 30 to 60 cm-long quadrupoles having gradients as high as 500 T/m; apertures are typically 2 to 6 cms. Such parameters lend themselves to beam lines capable of kinematic analysis and focusing in very short distances. with consequent minimised decay losses. All magnets are air-cored and water-cooled, with geometries tailored to suit particular experimental requirements. Of singular importance are the measures taken to distribute in-pulse loads and minimize fatigue so that lifetimes may be stretched to at least 200,000 shots. Special attention is paid to the cooling of otherwise-limiting components of clamping assemblies, permitting the pulsed beamline to operate at machine rates of 25 ppM, and even to double-pulse if necessary. (auth)

19184 ARGONNE SUPERCONDUCTING MAGNET POLARIZED PROTON TARGETS. Bywater, J.; Desportes, H.; Hill, D.; Laverick, C.; Moretti, A.; Purcell, J. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 675-677(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A dc superconducting C-frame magnet for use with polarized proton targets has been assembled and tested at ANL. This magnet has a vertical field of 25 k Gauss, uniform to within 4 parts in 10^4 over a 10 cm diameter, 2 cm high cylinder located at the center of the magnet's 10 cm high room temperature air gap. The magnet consists of two sets of coils each containing a main coil and a correction coil. Each set of coils is mounted on its own coil form and in its own liquid helium dewar with only a small bellow communication line between them. The field is shimmed by adjustment of the correction coil current and by mechanical adjustment of the position of the top set of coils relative to the bottom set. (auth)

19185 STUDIES OF PERFORMANCE AND FIELD REPRODUCIBILITY OF A PRECISION 40 kG SUPERCONDUCTING DIPOLE MAGNET. Allinger, J.; Danby, G.; DeVito, B.; Hsieh, S.; Jackson, J.; Prodell, A. (Brookhaven National Lab., Upton, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 678-682(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An 8° bending magnet system for 30 GeV primary protons from the Brookhaven AGS is to be installed in the summer of 1973. This bend requires operating two magnet modules, each 6-ft. long, at an excitation up to 37 kG. The cold bore I.D. is 3.375-in. A 20-in. long full-scale cross section model has been extensively tested. Multipole field components due to the magnet circuit, produce field error $\simeq 1 \times 10^{-4}$ parts below 20 kG out to the measurement radius at 82% of the radius to the superconductor. The "good field" ($\sim 1 \times 10^{-4}$ parts) shrinks to a radius ~50% of the radius to the superconductor by 40 kG. Diamagnetic effects in the superconductor are completely negligible by 5 kG, with the exception of the (r^4, 5θ) multipole. This contributes 6.5×10^{-4} parts to the field at 82% of radius. End effects are sufficiently small that for 6-ft. long magnets little or no modifications of end contours are required for even very exacting applications. The magnet has operated to 45 kG with no evidence of significant training. The magnet has been thermally cycled several times, and the field aberrations allowed by magnet design symmetries reproduce exactly from the first to last measurement runs. At 19.1 kG all allowed multipoles, i.e., 5θ, 7θ, 9θ, 11θ, with 3θ tuned to zero agree to 1×10^{-4} parts error over the duration of experimental measurements. However, ferromagnetic effects due to martensitic transformations in the stainless steel inner form on which the coils are wound have grown with repeated thermal and magnetic cycling. These effect particularly the remanence and the lower harmonic components at the lower dipole field levels. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 18272, 18356, 18362, 18363, and 19511.

19186 (CONF-700705-(Vol.2), pp 553-558) SOLID STATE STUDIES OF URANIUM MICRODISTRIBUTION IN METEORITES. Kaschkarov, L. L.; Lavrukhina, A. K.; Genaeva, L. I.; Yukina, L. V.; Vernadskii, V. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). 1970.

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The uranium content and its microdistribution in schreibersite, troilite minerals, and in metal phases of the iron meteorites Aroos, Gressk, and Sikhote-Alin was determined. For studying the induced fission tracks the autoradiography method was used. In various phases of iron meteorites inhomogeneous distribution of uranium concentration was observed. A lower limit of order 10^{-11} g/g was obtained for the uranium content in the metal phase of Sikhote-Alin meteorite. The highest uranium concentration was associated with mineral schreibersite and was equal to 10^{-8} g/g. In all investigations meteorites had the uranium content ratio for accessory minerals schreibersite, troilite, and metal phase approximately 300 : 10 : 1. (auth)

19187 (CONF-700705-(Vol.2), pp 611-648) ANNEALING OF FISSION TRACKS IN TEKTITES: CORRECTED AGES OF BEDIASITES. Durrani, S. A.; Khan, H. A. (Univ. of Birmingham, Eng.). 1970.

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Systematic annealing experiments were carried out in an endeavor to obtain quantitatively reliable correction factors for the ages of tektites which may have been subjected to heat. The standardization of etching conditions, which is a prerequisite for making such corrections, is described. The application of the correction factors so obtained to a differentially-annealed bediasite gives self-consistent results. Inferences as to the possible thermal history of the bediasite are drawn from a careful analysis of the etch-pit diameter vs track density histograms of natural as well as freshly irradiated samples. The mechanism of track shrinkage and fading is examined in some detail. (auth)

19188 (CONF-700705-(Vol.2), pp 649-654) LENGTH OF TRACKS PRODUCED BY IRON IONS IN FELDSPARS AND PYROXENES MEASURED BY A REPLICA TECHNIQUE. Pleininger, T. (Max-Planck-Institut fuer Kernphysik, Heidelberg). 1970.

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Polished sections of feldspars and pyroxenes were exposed to 10- to 80-MeV Fe ions of a tandem Van de Graaff. After suitable etching a plastic replica was made of the etch pits. It revealed length and shape of the tracks when studied under the Stereoscan microscope (magnification up to 50,000). The measured tracks lengths were compared with theoretical range data. (auth)

19189 (CONF-700705-(Vol.2), pp 655-666) REGISTRATION OF TRACKS FROM NUCLEAR INTERACTIONS IN PYROXENES AND FELDSPARS OF LUNAR, METEORITIC, AND TERRESTRIAL ORIGIN. Bastin, G.; Borg, J.; Dran, J. C.; Maurette, M.; Vassent, B. (CNRS, Orsay, France).

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The several experiments carried out with a converter made it possible to study several characteristics of the sensitivity of observable tracks of heavy ions in pyroxenes and lunar feldspars. The feldspars are better detectors than the pyroxenes which manifest a nonuniformity in the sensitivity of registration probably related to the local variations in their chemical composition. The tracks are probably produced by the inelastic interactions of the incident particles with the atoms of the converter. (tr-auth)

19190 (CONF-700705-(Vol.2), pp 667-670) HIGH VOLTAGE ELECTRON MICROSCOPE STUDIES OF EXTRA-TERRESTRIAL MATTER. Borg, J. (CNRS, Orsay, France); Dran, J. C.; Durrieu, L.; Jouret, C.; Maurette, M. 1970.

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Nuclear particle tracks, crystal habits, and electron diffraction patterns were studied in lunar and meteoritic materials with a 1-MeV electron microscope. (WDM)

19191 (ESRO-SP-74, pp 67-69) S-24B MEASUREMENTS DURING PERIODS OF LOW SOLAR ACTIVITY. Dyer, C. S.; Engel, A. R. (Imperial Coll., London). Mar 1972.

A summary of high-energy proton measurements made by experiment S-24B during periods of low solar activity is presented. This experiment makes directional measurements on protons greater than 360 MeV and also contains a channel with a less well defined threshold of about 30 MeV. One of the aims of the experiment was to monitor any small anisotropies in the primary cosmic radiation originating outside the solar system. (FR)

19192 NEUTRON MEASUREMENTS IN SPACE. Lockwood, J. A. (Univ. of New Hampshire, Durham). Space Sci. Rev.; 14: No. 5, 663-719(Jun 1973).

The experimental measurements of the neutron flux and energy spectrum in space since 1964 are reviewed and related to the theoretical predictions. A discussion of the neutron sources is presented. The difficulties associated with neutron measurements of both the atmospheric neutron leakage flux and solar neutrons are included. Particular emphasis is placed upon the neutron leakage flux and energy measurements at energies greater than about 1 MeV. The possibilities of CRAND as a source for the energetic trapped protons are discussed in light of recent measurements of the 10 to 100-MeV neutron flux. The current status of the solar neutron flux observations is also presented. The primary purposes of neutron measurements in space have been to determine the neutron leakage flux from the atmosphere of the Earth and the solar neutron flux. As a consequence of the inefficient methods for neutron detection and the difficulties of conducting the measurements in the presence of the galactic and solar cosmic-ray backgrounds, the experimental results are very conflicting. It is the purpose of this review to interpret and discuss recent neutron measurements. In order to understand these results the theoretical predictions of the neutron fluxes and energy spectra from possible neutron sources will be briefly presented. Since comparisons of the different neutron measurements depend critically upon the experimental techniques, neutron detection methods applicable to space measurements are briefly discussed. The emphasis is upon measurements since 1964 made outside the Earth's atmosphere, but considerable reference is made to high-energy neutron experiments conducted within the Earth's atmosphere at <10 g cm^{-2} altitude. A review of earlier neutron measurements of terrestrial and solar neutrons has been made by Haymes (1965). (auth)

19193 (N-73-17829) LOW ENERGY COSMIC RAY PROTONS FROM NUCLEAR INTERACTIONS OF COSMIC RAYS WITH THE INTERSTELLAR MEDIUM. Wang, H. T. (National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center). Feb 1973. 15p. (NASA-TM-X-66181). NTIS.

The flux of secondary protons below 100 MeV in interstellar space is calculated using detailed cross sections and kinematics for proton-proton, and proton-alpha particle interactions. (STAR) (auth)

19194 (N-73-17830) PRIMARY COSMIC RAY ELECTRONS ABOVE 10 GeV: EVIDENCE FOR A SPECTRAL BREAK. Silverberg, R. F.; Ormes, J. F.; Balasubrahmanyan, V. K. (National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center). Jan 1973. 23p. (NASA-TM-X-66182). NTIS.

A balloon borne measurement of the cosmic-ray electron spectrum from 10 to 200 GeV is reported in which two new techniques were used to remove proton background contamination. First, the depth of the spectrometer was more than 25 radiation lengths, the equivalent of more than 2 mean free paths of material, enabling hadronically and electromagnetically induced cascades to be differentiated for a subset of the data. Second, electromagnetic cascade starting points were determined to within ± 0.1 radiation lengths based upon a calibration with electrons from 5.4 to 18 GeV at the Stanford Linear Accelerator, greatly reducing the chances for a proton to simulate an electron. The resulting spectrum, when fitted with a power law, is quite steep, -3.2 ± 0.1, but the chi-square fit is marginal. A significantly better fit is achieved assuming a transition region model in which the source spectral index is 2.7 with a break occurring at about 50 GeV. (STAR) (auth)

19195 (N-73-19703) ULTRAHIGH ENERGY PHOTON SPECTRUM. Stecker, F. W.; Bredekamp, J. (National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center). Dec 1972. 10p. (NASA-TM-X-66198). NTIS.

Results are made of a numerical calculation of the ultrahigh energy photon spectrum. After assuming that the ultrahigh energy cosmic-ray nucleons are universal calculations are made without

resorting to the previously employed delta function approximation. (STAR) (auth)

19196 STUDY OF HEAVY TRANS-IRON PRIMARY COSMIC RAYS ($Z \geq 55$) WITH A FAST FILM CHERENKOV DETECTOR. Pinsky, L. S. Rochester, NY; Univ. of Rochester (1973). 221p. University Microfilms Order No. 73-14,831.

Thesis (Ph.D.).

A stack consisting of a fast film Cherenkov detector, nuclear emulsions, and plastic track detectors, was flown from Minneapolis, Minnesota, in Sept. 1970, and a total exposure of roughly 1.5×10^3 m^2 hours was accumulated at altitudes above 6 gm/cm^2. The fast film Cherenkov detector was designed to provide velocity measurements for particles with $Z \geq 55$, and $\beta > 0.68$. Of 27 events found in the nuclear emulsion with estimated charges of at least 50, 10 had Cherenkov images which have given velocity estimates that correspond well with the plastic and emulsion velocity estimates. The remaining events were either below the charge or the velocity threshold of the fast film Cherenkov detector. The $Z > 60$ charge spectrum from this balloon flight, when combined with the results from previous experiments, indicates that the source spectrum is the product of an r-process nucleosynthesis. When reasonable assumptions about the source abundances are made, the results of slab model cosmic-ray propagation calculations are inconsistent with the data. The index of the differential total energy per nucleon spectrum from the plastic and emulsion data for $Z > 60$, and kinetic energies per nucleon between 600 and 1400 MeV/N (at the top of the atmosphere) is 6.5 ± 1.7. A similar calculation based only on the fast film Cherenkov detector data gives $8.8^{+3.3}_{-2.5}$. This index is in disagreement with the accepted value of 2.6 for sub-iron cosmic-ray nuclei. This experiment has demonstrated the ability of the fast film Cherenkov detector to measure the velocities of $Z \geq 55$ and $\beta > 0.68$ cosmic rays. (Diss. Abstr. Int., B)

19197 COSMIC RAYS OVER THE UPPER MID-WEST. Rygg, T. A. College Park, MD; Univ. of Maryland (1972). 181p. University Microfilms Order No. 72-17,050.

Thesis (Ph.D.).

Differential energy spectra of cosmic ray protons and helium nuclei in the energy range 100 to 260 MeV/nucleon were measured on balloon flights from Minneapolis, Minnesota and from Sioux Falls, South Dakota. The energy spectrum of re-entrant albedo protons was found to be essentially flat in the 100 to 200 MeV interval as is predicted by theoretical calculations of the equilibrium spectrum of secondary protons emerging from thick layers of air. Geomagnetic cutoff rigidities obtained during quiet times from the spectra of helium nuclei were variable from day to day averaging 23% below the level predicted by detailed orbit calculations that invoke only internal sources of the Earth's magnetic field. Correlation of the cutoff with the Earth's equatorial field suggested that the source of the variation is a fluctuating ring current located within the radiation belt at ~7 R_E. During the magnetic storm of August 30, 1966, the cutoff was observed to be depressed at times below 40% of its quiet time level, but it was restored to nearly the normal level during the positive phase of the storm. Because of the depressed cutoffs, it was possible to measure the spectrum of primary protons just before and during the Forbush decrease of August 30, 1966 and thus to show that the form of these spectra was identical to that observed throughout the solar cycle with the same instrument. Specifically, the spectrum of protons during the most deeply modulated period that was observed followed the same law, $J = AT$, where J is the differential intensity, T is kinetic energy, and A is a parameter independent of energy but variable in time, that characterizes the modulated spectrum of primary protons. The solar cycle variation of atmospheric secondary protons was investigated. It was found that the intensity of secondary protons varied by 40% over the solar cycle and was in good agreement with a theoretical model of atmospheric propagation. (Diss. Abstr. Int., B)

19198 He, Ne, AND Ar IN CHONDRITIC Ni–Fe AS IRRADIATION HARDNESS SENSORS. Nyquist, L.; Funk, H.; Schultz, L.; Signer, P. (Swiss Federal Inst. of Tech., Zurich). Geochim. Cosmochim. Acta; 37: No. 7, 1655-1685(Jul 1973).

Noble gas analyses of the Ni–Fe of 9 L, 5 H, and 2 LL chondrites quantitatively support previous suggestions of radiogenic ^4He recoil and ^3He deficits. Furthermore, noble gases in the Ni–Fe show evidence for in situ produced radiogenic ^4He and in some cases for recoil loss of ^{38}Ar and gain of ^{21}Ne. The ratio of spallogenic ^{21}Ne and ^{38}Ar in the metal phase was found to correlate strongly with $^3He/^{21}Ne$ and $^{22}Ne/^{21}Ne$ in bulk samples of these chondrites. This is proof of the dependence of these ratios on the irradiation hardness experienced by the meteoroid in space. "Hardness indices" n = 1.9 to 2.2 were found, indicating that on the average the stone meteoroids from which the samples came were smaller in mass than iron meteoroids. The spallogenic $^{21}Ne/^{38}Ar$ ratio in metallic Ni–Fe can be used with the semi-empirical production model deduced from the Grant iron meteorite to calibrate spallogenic $^3He/^{21}Ne$ and $^{22}Ne/^{21}Ne$ in bulk samples of L, LL, and H chondrites for meteoroid size and sample location allowing the estimation of minimal meteoroid masses. ^3He and ^{21}Ne production rates calculated from previously determined $^{36}Ar/^{38}Ar$ exposure ages for four L chondrites indicated that they are probably not single-valued functions of the $^3He/^{21}Ne$ ratio. The ratio of ^3He in bulk samples to ^{38}Ar in metal samples of the same meteorite is constant ($= 20 \pm 3$), whereas the ratio of ^{21}Ne in the bulk to ^{38}Ar in the metal varies by as much as a factor of two in correlation with $^3He/^{21}Ne$. (auth)

19199 PERIODIC ANALYSIS OF ARRIVAL TIMES IN DELAYED COSMIC-RAY COINCIDENCES. Porter, N. A.; Lawless, B. G. (University Coll., Dublin). Lett. Nuovo Cim.; 7: No. 8, 277-281(23 Jun 1973).

Gunn and Ostriber (1969) proposed an efficient acceleration mechanism for cosmic rays in the vicinity of pulsars. While the theory is difficult to test directly, an observation of high-energy gamma rays from the direction of a pulsar would give supporting evidence for it. An experiment is described which attempted to observe these gamma rays. (WDM)

19200 GROUP SPACE RESEARCH. Introduction. 1. Wibberenz, G. (Univ., Kiel). Atomkernenergie; 20: No. 3, 189-190(1972). (In German).

A short survey is given of the different projects of the space research group which has been in existence since 1963 at the Institut fuer Reine und Angewandte Kernphysik of the University of Kiel. The experiments are described in separate papers. (GE)

19201 EXPERIMENT FROM KIEL FOR THE INVESTIGATION OF COSMIC RAYS IN THE SOLAR SPACE PROBE HELIOS. Kunow, H.; Green, G.; Mueller, R.; Witte, M.; Vollmers, H. Atomkernenergie; 20: No. 3, 193-194(1972). (In German).

A description is given of the design and the properties of an experiment to be flown in the solar space probe HELIOS which is presently under construction. The purpose of this experiment is to investigate the solar and galactic particles of the cosmic radiation by measuring their energy spectra, angular distributions, and time variations of the intensities. (GE)

19202 ELECTRONS OF THE GALACTIC COSMIC RADIATION. Beuermann, K. P. Atomkernenergie; 20: No. 3, 192 (1972). (In German).

By a model description of the transport mechanism of galactic electrons an attempt is made to gain some insight into the structure of interplanetary space. From the demodulated electron spectra and intensities in local interstellar space knowledge could be gained on the characteristics of sources and the transport mechanism in this region. (auth)

19203 ALUMINIUM-26 IN METEORITES. 7. Ureilites, Their Unique Radiation History. Wilkening, L. L.; Herman, G. F.; Anders, E. (Univ. of Chicago). Geochim. Cosmochim. Acta; 37: No. 7, 1803-1810(1973).

Cosmogenic ^{26}Al activities have been measured by γ–γ coincidence counting in the three ureilites which had not previously been studied. The values in dpm/kg are: Dingo Pup Donga, 38.4 ± 2.4; North Haig 39.3 ± 4.8; Dyalpur, 55.8 ± 4.8. Five of the six known ureilites thus have lower ^{26}Al contents, 63 to 77%, than the calculated saturation values, in marked contrast to most other stony meteorites. This cannot be attributed to short cosmic-ray exposure ages. Nor do size and depth effects account for the narrow range of ^{26}Al activities, because a nuclear particle track study indicates that preatmospheric radii were highly variable, from ≥40 cm for Goalpara to only a few cm for Dingo Pup Donga. By default, the most likely explanation is that the ureilites had much smaller or much larger orbits than all other stony meteorites. (auth)

Stars

Refer also to abstracts 19287 and 20077.

19204 (AD-757910) CARBON MONOXIDE AND HYDROGEN CYANIDE MILLIMETER-WAVE EMISSION FROM STARS. Report for October 1971–October 1972. Wilson, W. J.; Epstein, E. E.; Schwartz, P. R. (Aerospace Corp., El Segundo, Calif.). 30 Mar 1973. Contract F04701-72-C-0073. 28p. (SAMSO-TR-73-109). NTIS.

Thirty-four stars were surveyed for 2.6-mm CO emission and forty-nine for 3.4-mm HCN emission. CO and HCN emission lines were detected in the directions of the carbon stars IRS + 10216, IRC + 30219, and possibly IRC000382. Preliminary measurements indicate CO source sizes approximately greater than 60 sec. Extended CO emission sources were also found in the directions of

the stars R Mon and T Tau. The infrared source IRC + 40091 (LkH-alpha-101) near the H II region S 222 was also found to have CO emission. (auth)

19205 (N-73-17846) EVOLUTION OF STARS WITH SUPPRESSED CORE CONVECTION. Stothers, R. B.; Chin, C. W. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). [1972]. 15p. (NASA-TM-X-68944). NTIS.

Stellar evolution on the upper main sequence was computed for models of stars with cores assumed to be in radiative equilibrium, up to the point of central helium ignition. The role of the Schonberg-Chandrasekhar limit for an isothermal core is found to be critical for the evolutionary tracks. Observational data are used to rule out the hypothesis of evolution with radiative cores (in upper main-sequence stars) and, by implication, of magnetic fields that are sufficiently strong to have suppressed the core convention. (STAR) (auth)

19206 STUDY OF A REGION IN MONOCEROS. Riddle, R. K. College Park, MD; Univ. of Maryland (1972). 244p. University Microfilms Order No. 73-17,048.

Thesis (Ph.D.).

Using new UBVH$_\gamma$ photometry and spectral classifications for 48 stars in the Monoceros region, the membership of the dispersed part of the I Mon association is examined and 19 probable members are identified. A variable extinction solution based on these members along with 10 probable members of NGC 2244, which is the most dense part of the I Mon association, gives a value of 1730 ± 80pc for the distance to the association. The values of the ratio of total-to-selective absorption, R, and the color-excess ratio, χ, are discussed from both the theoretical and observational standpoints, and the values found appropriate for use in this region are 2.98 ± 0.23 and 0.70 ± 0.01, respectively. The color-magnitude diagram suggests that the dispersed group of I Mon stars is older than the cluster NGC 2244. The Palomar Sky Survey photographs are used as the basis for an examination of the distribution of dust clouds in the region of the I and II Mon associations. A study is made of interstellar reddening as a function of stellar distance and position in the sky. A large dust cloud is found to be part of the I Mon complex, as is the large Monoceros Nebulosity hydrogen emission loop structure. Previously existing neutral hydrogen 21-cm emission line data is examined and the distribution of neutral hydrogen is found to be well correlated with the areas of several opaque dust clouds seen in I Mon and II Mon. (Diss. Abstr. Int., B)

19207 STUDY OF THE INFRARED SPECTRA OF K-GIANTS. Ridgway, S. T. Stony Brook, NY; State Univ. of New York (1972). 173p. University Microfilms Order No. 73-15,908.

Thesis (Ph.D.).

The construction of a rapid scanning Fourier spectrometer system for astronomical infrared spectroscopy and photometry is described. Problems of phase error, nonuniform mirror velocity, and atmospheric extinction were studied in detail. A survey of 16 bright K-giants exhibited a strong correlation between CN excess and CO excess. Using model atmospheres and spectral synthesis, the $^{12}C/^{13}C$ ratio is shown to be in the range 10 to 30 for most of the stars. The significance of these results is considered in the light of present understanding of stellar evolution. (Diss. Abstr. Int., B)

19208 INTEGRAL EQUATION METHOD FOR TRANSFER PROBLEMS IN INFINITE CYLINDRICAL SHELL MEDIA. Leong, T. K.; Sen, K. K. (Univ. of Singapore). Publ. Astron. Soc. Jap.; 23: No. 2, 247-262(1971).

The Fredholm type of integral equation for transfer problems in inhomogeneous, isotropically scattering infinite cylindrical shell media was solved by utilizing the method of the Fredholm theorem for general L_2-kernel. It is shown that the process of breaking up the L_2-kernel occurring in such an integral equation into a sum of the Pincherle-Goursat kernel and another L_2-kernel proves equally effective in the case of cylindrical geometry as in the case of spherical geometry (Leong and Sen 1971). (auth)

19209 QUADRATIC ZEEMAN EFFECT OF HYDROGEN BALMER SERIES. Hamada, T. (Ibaraki Univ., Mito, Japan). Publ. Astron. Soc. Jap.; 23: No. 2, 271-273(1971).

Recent discussion by Preston (1970) of the quadratic Zeeman effect of Balmer absorption lines refers only to the transitions from the 2S level of a hydrogen atom. The transitions from the degenerate 2P level are considered. It is found that the blue shifts due to quadratic Zeeman effect are smaller by 10 to 40% than the corresponding shifts obtained by Preston (1970). This result does not, however, call for any qualitative modification of the conclusion that the magnetic fields in DA stars are probably less than 10^5 Gauss. (auth)

19210 SOLUTION OF THE RESTRICTED TWO-LEVEL LINE FORMATION PROBLEM. Ueno, S. (Kyoto Univ.). Publ. Astron. Soc. Jap.; 23: No. 2, 239-245(1971).

With the aid of the initial-value method, it is shown how to solve rigorously the combined equations of statistical equilibrium and radiative transfer for line transitions between two discrete energy levels. Stimulated emission and complete re-distribution in frequency of energy are assumed, whereas local thermodynamical equilibrium is not allowed for. An alternative approach to the solution of diffuse reflection problem is presented. (auth)

19211 THERMAL-CONVECTIVE INSTABILITY IN A STELLAR ATMOSPHERE. Bhatia, P. K. (Monash Univ., Clayton, Australia). Publ. Astron. Soc. Jap.; 23: No. 2, 181-184(1971).

The problem of thermal-convective instability of a stellar atmosphere, when the effects of a uniform rotation and a uniform magnetic field are included simultaneously, is discussed. It is found that the criterion for monotonic instability is the same as in the absence or presence (separately) of these two effects. (auth)

19212 RADIAL VELOCITIES OF 25 BRIGHT B3V STARS. Kodaira, K. (Univ. of Tokyo, Mitaka, Japan). Publ. Astron. Soc. Jap.; 23: No. 2, 159-180(1971).

Results of the radial velocity measurements of 25 northern bright B3V stars ($m_V \lesssim 5.5$, $\delta > -16°$), based on 388 spectrograms (20 Å/mm), are presented. Of these 25 stars, 18 are suspected to have variability in their velocity, and their velocity-curves are proposed. Interpreting them as spectroscopic binaries, it is concluded that the apparent slow rotators tend toward longer periods. A short discussion is given about a possible excess of binary systems with a secondary of about $1M_\odot$, and it is proposed to use a frequency function $\Phi(\alpha; m_1)$, instead of the $\Phi(\alpha)$ function conventionally used. (auth)

19213 EVOLUTIONARY ORIGIN OF THE MAGNETIC FIELD ON PULSARS AND ITS RELATION TO OTHER TYPES OF STARS. Imoto, M. (Scuola Normale Superiore, Pisa, Italy); Kanai, M. Publ. Astron. Soc. Jap.; 23: No. 3, 363-370(1971).

Accompanying the compression of matter, the magnetic field in the stellar interior can be much stronger than that on the surface. It is proposed that the fields of pulsars are the naked inner ones which have been condensed, accompanying the compression of matter, and which are then exposed by a supernova explosion. This also suggests the similar origin of the unexpectedly strong magnetic field observed on a DC type white dwarf, and provides a schematic understanding of the variation of the stellar magnetic field along stellar evolution. (auth)

19214 CLOSE BINARY SYSTEM R CANIS MAJORIS. Sato, K. (International Latitude Observatory, Mizusawa, Japan). Publ. Astron. Soc. Jap.; 23: No. 3, 335-362(1971).

Photoelectric studies in UBV of the baffling eclipsing variable R CMa were carried out with the 36-inch reflector of Dodaira Station of Tokyo Astronomical Observatory. Photoelectric observations for Hβ-indices were also made with the 36-inch reflector of Okayama Astrophysical Observatory, which confirmed that the primary component of R CMa is an F1V-type star. Photometric elements of the eclipsing system are discussed with the use of the light curve in yellow (V). Principal photometric elements deduced are $r_1 = 0.325$, $r_2 = 0.219$, $i = 80$, and $L_1 = 0.937$. Combining with the spectrographic observations, the absolute values of masses and radii of the system were obtained as $m_1 = 1.78\ M_\odot$, $m_2 = 0.22\ M_\odot$, $R_1 = 1.88\ R_\odot$, and $R_2 = 1.24\ R_\odot$, though some ambiguities remain. The possibility is indicated that R CMa may be an ordinary semi-detached system so that the classification of the so-called R CMa-type might be demised. (auth)

19215 ATMOSPHERIC STRUCTURE, MASS LOSS, AND CHEMICAL COMPOSITION IN R ANDROMEDAE AND R CYGNI. Tsuji, T. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 3, 275-312 (1971).

High-dispersion spectra of the Se-type, Mira variables, R Andromedae and R Cygni, show certain spectroscopic features in the near infrared; (1) most absorption lines which were single at maximum phase appear at post-maximum with a violet-displaced component, characterized by higher-excitation temperature, and also shallower and relatively wider line profiles, as compared with the normal absorption components. (2) Zero-volt lines, like those of K, Rb, Li, Y, and Zr, have short wavelength component both at maximum and post-maximum phases. (3) CN lines are strong only at the violet-displaced position. Their radial velocity differs, however, by several km/sec, their profile appears to be more shallow, and their excitation temperature much higher, in contrast with the violet-displaced atomic lines. (4) The emission lines of the Hα and Ca II triplet are strong and displaced to the violet. The absorption component of Hα appears at its normal position. (WDM)

19216 SPECTRAL ANALYSES OF SOME MIRA-TYPE LONG-PERIOD VARIABLE STARS. Maehara, H. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 3, 313-333(1971).

Spectral analyses were made for the spectrograms obtained near the light maximum of seven Mira-type long-period variable stars: χ Cygni, o Ceti, R Leonis, R Hydrae, R Trianguli, T Ursae Majoris, and R Cassiopeiae. For each spectrogram, identifications of spectral lines were made, and equivalent widths were measured. It was found that the empirical curve-of-growth does not give a unique excitation temperature; high excitation temperatures are derived from high excitation lines and vice versa. In particular, quite a large range in the excitation temperature between high and low excitation lines was found for χ Cygni ($\theta_{exc} \cong 1.0-3.0$). This probably comes from temperature stratification in the atmosphere, though other factors may play an important role. The Doppler velocity ranges from 3 to 8 km s^{-1}. The damping constant is rather small when the mean excitation temperature is adopted. Electron pressures are very low, though their values cannot be determined precisely. In the spectrograms of the 1969 cycle of o Ceti (Mira), line weakening was observed; all absorption lines are weakened, but strong lines such as Ca I (2) and Cr I (1) are extraordinarily weakened. The excitation temperature was relatively well determined, in contrast with the spectra in the strong-line cycle. The main cause of the line weakening in o Ceti is not due to metal deficiency, but to the variation of physical conditions in the atmosphere associated with the stellar pulsation. (auth)

19217 SPECTROGRAPHIC BINARY HD 180553. Hube, D. P. (Univ. of Alberta, Edmonton). Astron. Astrophys., Suppl. Ser.; 10: No. 2, 267-272(May 1973).

Observational material obtained with the 1.88 m reflector of the David Dunlap Observatory was used in determining the orbital elements of the short period, B-type spectrographic binary HD 180553. The system is also a close visual binary, a fact which almost certainly has had an adverse effect on the reliability of the derived elements. (auth)

19218 INTERSTELLAR D-LINES IN THE SPECTRA OF CARBON STARS, HD182040, T LYRAE, AND V AQUILAE. Utsumi, K. (Hiroshima Univ.); Yamashita, Y. Publ. Astron. Soc. Jap.; 23: No. 3, 437-441(1971).

Interstellar D-lines are found in the spectra of the carbon stars, $H_2$182040, T Lyr, and V Aql. The distances of the stars, and then the absolute magnitudes are estimated from the equivalent width of interstellar D-lines. These values agree with the previous determinations made by several authors. Since the interstellar D-lines are fairly strong in the spectrum of HD182040, the discrepancy that previously existed in the intensity of D-lines is almost removed. (auth)

19219 PERIOD RADIUS RELATION FOR CEPHEID VARIABLE STARS. Woolley, R.; Carter, B. (Royal Observatory, Cape Town). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 379-400(1973).

Eighteen determinations of the radii of cepheid variables by the Baade–Wesselink method are described. A very close linear relation between the logarithm of the radii and the logarithm of the period is found. This is compared with radii found from data given by Sandage and Tammann (Astrophys. J.; 157: 683(1969)), using a modification of Wesselink's tables (Mon. Not. R. Astr. Soc.; 144: 297(1969)) of specific intensity as a function of color. This modification is discussed. The special position of W Virginis stars in the radius–period diagram is discussed, and the field stars are compared with data from globular cluster stars as reported by Dickens and Carey (R. Obs. Bull.; 129(1967)). (auth)

19220 SOLID CORE IN NEUTRON STARS. Canuto, V.; Chitre, S. M. (Goddard Inst. for Space Studies, New York). Nature (London) Phys. Sci.; 243: No. 126, 63-65(28 May 1973).

It is stated that the identification of pulsars as rotating neutron stars has led to an increased interest in the structure calculation of neutron stars. While the state of matter in the outer regions of a neutron star is relatively well understood, knowledge of the equation of state in the density range above 10^{15} g/cm^3 is far from clear. Calculations are presented designed to show that under conditions of pressure and density that typically prevail in the interior of a neutron star a system of strongly interacting baryons minimize the energy by arranging the constituents in a lattice structure. Previous calculations have indicated that the solidification density of neutron matter is of the order of 5×10^{14} g/cm^3, and this raises the question as to whether a neutron star may have a crystalline structure throughout its interior. Arguments based on the law of corresponding states can only provide a semi-quantitative answer to the question of solidification of neutron matter under a sufficiently high pressure; the exact density for the onset of a solid phase must be determined by a refined quantum mechanical calculation. In order to investigate the energetics of a neutron lattice three different configurations were studied: BCG, FCC, and HCP. It is concluded that the solid phase (FCC) for cold neutron matter is energetically preferable at densities 71.6×10^{15} g/cm^3. Neutron star models were constructed composed of cold matter by integrating the relativistic equations of stellar structure, and these are compared with previous models. There is one piece of observational evidence to support the idea of a solid neutron core for heavy neutron stars; the starquake theory of pulsar spinups (glitches) and the subsequent healing which has so successfully been applied to account for the behavior of the Crab pulsar can explain the observational features associated with the Vela pulsar only if it is assumed that the latter possesses a solid crystalline core. The presence of repeated spinups of pulsars has independently brought substantial credibility to the idea of a possible solid core inside a neutron star. (UK)

19221 SPECTRUM OF SUPERNOVA IN NGC 5055. Kikuchi, S. (Univ. of Tokyo, Mitaka, Japan). Publ. Astron. Soc. Jap.; 23: No. 4, 593-596(1971).

Two spectrograms of the supernova in NGC 5055 were obtained on May 25, 1971. The spectrum shows the features of type I supernova. (auth)

19222 EFFECT OF MOLECULAR LINE ABSORPTIONS ON STELLAR OPACITIES. Tsuji, T. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 4, 553-565(1971).

Some properties of stellar opacities at relatively low temperatures are studied. The effects of several opacity sources such as H_2O (vibration–rotation and pure rotation bands), TiO (electronic bands), H_2 (collision-induced absorption), etc. are discussed. It is found that, in general, the collision-induced H_2 absorption is quite important and that TiO absorption is equally as important as H_2O absorption. The applicability as well as the limitation of some approximate methods to evaluate the Rosseland mean opacity are examined. It is shown that a very simple calculation of H_2O opacity based on the just-overlapping line approximation gives essentially the same result as that obtained from a detailed line-by-line calculation now available. For diatomic molecules, the Voigt-analogue-Elsasser band model is applied to evaluate mean absorptions. Some approximate values of the Rosseland and the Planck mean opacities are given. (auth)

19223 STUDY ON DIFFERENTIAL RADIAL VELOCITIES IN THE SPECTRA OF CHI CYGNI AND OMICRON CETI. Maehara, H. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 4, 503-528 (1971).

The spectra of two typical Mira-type variable stars, χ Cygni and o Ceti (Mira) were studied in order to investigate the dynamical structure of their atmospheres. Differential radial velocities were found for the absorption lines observed near the light maximum. A linear relationship between the radial velocity and the line strength, log X_f, was obtained for χ Cygni. This relationship indicates that the outer region of the atmosphere expands faster than the inner region. A similar relationship was also found for the emission lines of Fe I at phase 0.4. For o Ceti, the relationship is not linear, indicating the existence of a rather complicated velocity field in the atmosphere of this star. (WDM)

19224 ROTATION OF STARS IN BINARY SYSTEMS. Nariai, K. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 4, 529-538 (1971).

The period–rotational velocity relation of binary systems is discussed by using published rotational velocities for double-line spectroscopic binaries and Olson's (1968) data for eclipsing binaries. It is found that the periods of rotation and orbital motion are close to each other for Am stars and Hg–Mn type Ap stars with periods less than 10 days, but the deviation from synchronism for normal main-sequence stars is found to be large. A study of P–V sin i diagrams for normal main-sequence stars as components of double-line and single-line binaries also indicates that the above conclusion is correct. (auth)

19225 NONRADIAL OSCILLATIONS AND THE BETA CANIS MAJORIS PHENOMENON. Osaki, Y. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 4, 485-502(1971).

Ledoux's (1951) theory of nonradial oscillations for the β Canis Majoris phenomenon is examined. Results for line profiles and radial velocity curves are compared with observations. Rotational velocities predicted from the beat periods do not seem to contradict those obtained from line widths. It is concluded that purely nonradial oscillations can explain most of the fundamental properties of the β Canis Majoris stars. (auth)

19226 SHORT PERIOD SPECTRAL VARIATIONS IN γ^2 VELORUM. Jeffers, S.; Weller, W.; Sanyal, A. (York Univ., Toronto). Nature (London) Phys. Sci.; 243: No. 129, 109-111 (18 Jun 1973).

γ^2 Velorum is a spectroscopic binary with a Wolf-Rayet (WC8) and a 091 star as companions. A period of 78.5d has been found

for the system, together with variations in the shapes of the He I emission lines in a time period of days. Recent observations (October and November 1972) are described, made with a rapid scanning spectrometer which allowed spectral variations to be studied on a time scale of 10 s, using the 24 inch telescope at the Las Campanas Observatory of the Carnegie Institute in Chile as part of a survey of short period spectral variability of emission line objects. The data were recorded on calibrated magnetic tape and monitored on an oscilloscope screen, and the wavelength region reported here was centered on 4660. (UK)

19227 RELATIVISTIC ASTROPHYSICS. IV. Relativistics, Rotating Stars. Part 1. Theoretical Foundations. Abramovich, M. A. (Zaklad Astronomii PAN, Warsaw). Postepy Astron.; 21: No. 2, 87-114(1973). (In Polish).

Papers describing the principal known properties of the relativistic, rotating stars are reviewed. It was intended to do this in a general way without reference to any particular coordinate system. Some results are presented for the first time. (auth)

19228 CATALOG OF AM STARS WITH KNOWN SPECTRAL TYPES. Hauck, B. (Univ., Lausanne, Switzerland). Astron. Astrophys., Suppl. Ser.; 10: No. 2, 385-403(Jun 1973).

A catalog is presented for all Am stars with known spectral types with respect to hydrogen-lines, K-line, and metallic lines. This catalog contains 418 stars. (auth)

19229 MORE ON THE EFFECTS OF THE RELATIVE SHIFTS OF THE MINIMA OF ECLIPSING BINARIES. Frasinski, L. (Central Section Observatory, Krakow). Postepy Astron.; 21: No. 2, 141-143(1973). (In Polish).

The paper refers to a paper of T. Z. Dworak (1972, Postepy Astronomii 20, 251). It is shown that the effect of relative shifts of the minima of eclipsing binaries is twice as large as that given by Dworak. (auth)

19230 SOUTHERN OPEN STAR CLUSTERS. III. UBV–Hβ Photometry of 28 Clusters Between Galactic Longitudes 297° and 353°. Moffat, A. F. J.; Vogt, N. (Ruhr Univ., Bochum, Ger.). Astron. Astrophys., Suppl. Ser.; 10: No. 2, 135-193(May 1973).

Photoelectric photometry yields 22 certain clusters. The parameters of each cluster are summarized. Seven clusters have spectral types earlier than B3: two of these fall in Becker and Fenkart's (1970) inner arm–II; the other five are located in the inner arm–I and yield no change in the structure obtained from previous studies of young open clusters. Suspected supergiants have been found in ten of the clusters. (auth)

19231 TEN-COLOR INTERMEDIATE-BAND PHOTOMETRY OF STARS. Faber, S. M. (Harvard Univ., Cambridge, MA). Astron. Astrophys., Suppl. Ser.; 10: No. 2, 201-216(May 1973).

Measurements of 148 stars on a 10-color photometric system are presented. The magnitudes were calibrated absolutely through the observation of standard stars. The reddening-free ultraviolet excess δ(38 to 41)* correlates closely with [Fe/H] for G dwarfs. However, the relationship between the cyanogen anomaly, δC_m(41 to 42), and [Fe/H] for G and K giants is unclear for stars more metal-rich than the Sun. Various interpretations of the data are discussed. (auth)

19232 UBV PHOTOMETRY AND PHOTOMETIC ORBIT OF UV LYN. Bossen, H. (Hamburg Observatory). Astron. Astrophys., Suppl. Ser.; 10: No. 2, 217-230(May 1973).

During photoelectric observations the eclipsing binary UV Lyn turned out to be a W UMa star with a period of 0.415d. Orbital elements were calculated and they show that the system consists of an F8 and a G0V star. Calculation of absolute elements shows that the earlier star has most likely evolved and is therefore oversized for its mass. (auth)

19233 EFFECT OF EXTERNAL RADIATION ON EMISSION-LINE INTENSITY. Ishizawa, T. (Kyoto Univ.). Publ. Astron. Soc. Jap.; 23: No. 1, 121-122(1971).

The emission-line intensity of a two-level atom is calculated for a uniform finite atmosphere which is illuminated by external radiation on both sides. It is assumed that the source function is independent of frequency, that the line is purely Doppler broadened, and that the external radiation is constant over the line. It is found that the external radiation has an important effect if $E_0 > \epsilon BT$, where E_0 is the intensity of the external radiation, ϵ is the probability per scattering that a photon will be lost from the line by collisional de-excitation, B is the Planck function, and T is the total optical thickness. (auth)

19234 INTEGRAL EQUATION METHOD FOR TRANSFER PROBLEMS IN SPHERICAL SHELL MEDIA. Leong, T. K.; Sen, K. K. (Univ. of Singapore). Publ. Astron. Soc. Jap.; 23: No. 1, 99-115(1971).

The Fredholm type of integral equation for transfer problems in homogeneous spherical shell media has been solved by an extension of Pincherle–Goursat kernel method for attenuation coefficients varying as the inverse power of radial distance. (auth)

19235 PRE-MAIN-SEQUENCE EVOLUTION OF CLOSE BINARY SYSTEMS. Yamasaki, A. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 1, 33-55(1971).

The initial conditions imposed on a close binary system whose components initiate their evolution from the Hayashi track are classified into three types. The "detached system" (type D) evolves without any loss of mass and angular momentum. In the "semi-detached system" (type S), the primary component overflows from the inner critical lobe and excess mass is transferred to the non-overflowed secondary. In the "contact system" (type C), both components overflow from the critical lobes and both mass and angular momentum are lost from the system. Subsequent evolutions are followed by numerical integration for various initial conditions in the cases of S and C types. The initial total mass is fixed at 13.5 $M_\odot$, and the mass flow rate and the angular momentum loss rate are given as parameters. In the system of type S, if the actual mass flow is more efficient than the critical value, mass transfer causes an instability. In the case of less efficient mass flow, the binary system ends in a detached system with a mutual separation smaller than the initial one. In the system of type C, if the actual angular momentum loss rate exceeds the critical value, mass and angular momentum losses give rise to an instability. With less efficient loss rate the system finally settles down to a detached system. Mass inversion between the components sometimes occurs due to a large amount of mass transfer. When the overflow of this system ceases, the lighter component becomes undersized, in agreement with observations of Kopal's undersize subgiant secondary. However, their mutual separation is much wider than the observed one. The possibility of obtaining models which can simulate the observed binary systems is discussed briefly. (auth)

19236 PLEADING FOR HYDRODYNAMICS. Zahn, J. P. (Observatoire, Nice). pp 371 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

The importance of hydrodynamics (turbulence, convection, heat, and matter transport) in stellar models is discussed. (FR)

19237 PERSPECTIVES FOR OBSERVATIONS OF PROTOSTARS. Lequex, J. (Observatoire de Paris, Meudon, France). pp 372-375 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

The future possibilities for ir and molecular radio emission observations of interstellar matter are discussed together with the possibilities of observing the different later stages in the evolution of protostars. (FR)

19238 SEARCH FOR WEAK LONGITUDINAL MAGNETIC FIELDS IN BRIGHT STARS. Borra, E. F. London, Ont.; Univ. of Western Ontario (1972). National Library of Canada, Ottawa. Thesis (Ph. D.).

The results of a search for weak longitudinal magnetic fields in bright stars using a photoelectric polarimeter and coudé line profile scanner are reported. γ Cygni appeared to have a longitudinal magnetic field of the order of a few hundred gauss. There was some evidence for a longitudinal field of the same order of magnitude in α Arietis and α Aurigae. High-resolution (0.038 A) polarization observations were obtained with a Fabry–Perot interferometer for α^2 Librae, Sirius, λ Coronae Borealis, and β Coronae Borealis. Upper limits ranging from 5 to 200 gauss are reported for 16 other stars. The problems of spurious instrumental polarization and phase shifts and of the efficiency of the instrument were examined. Techniques of observation and reduction were developed and tested using numerical models under the main assumptions of dipole geometry and Milne–Eddington approximation. Oblique rotator models for the magnetic stars β Coronae Borealis and 53 Camelopardalis are briefly discussed and compared to existing observations. (Diss. Abstr. Int., B)

19239 CHEMICALLY PECULIAR STARS OF THE UPPER MAIN SEQUENCE. Preston, G. W. (Hale Observatories, Pasadena, CA). Nucl. Instrum. Methods; 110: 405-410(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

Abundance anomalies of two classes of peculiar main sequence stars are reviewed. The anomalies include gross overabundances of some elements and deficiencies of others. Isotopic abundances of three elements appear to be abnormal. (auth)

19240 BLUE–VIOLET INTENSITY DISTRIBUTIONS IN S, C–S, AND C STARS. Ross, H. E. Cleveland; Case Western Reserve Univ. (1973). 60p. University Microfilms Order No. 73-16,151.

Thesis (Ph.D.).

Blue-violet intensity distributions are given for fifteen S, three C–S, and three C stars. The dissimilarities between the intensity distributions of AM Cen and Y CVn (Feast 1957) appear to be due to overlapping absorption lines and bands. The violet depression increases continuously from S stars (of middle temperature and abundance classes) through C–S stars to N-type carbon stars. It is suggested that the violet opacity mainly responsible for this depression originates in the upper layers of the star's atmosphere. Caution must be used in interpreting the wavelength dependence of the violet opacity determined by McKellar and Richardson (1955), since the comparison stars used have been found to be stars showing significant violet depression themselves. Solid SiC appears to be a strong candidate for the agent causing the violet depression, although it is not clear whether SiC can be sufficiently abundant in the S stars. The characteristic curve can be fitted by an exponential fit for the toe, merging with a linear fit for the linear portion. The characteristic curve is then described by two parameters. Variations of these parameters with wavelength, exposure time, and background fog are discussed. The toe of the characteristic curve, which covers a range of densities frequently used by astronomers, shows nontrivial variations with exposure time, wavelength, and background fog. MWP-2 considerably exaggerates these effects in comparison with D-19. MWP-2 should be used with great care when large density ranges and wavelength ranges are involved; the calibration exposures should then be tailored to match the stellar exposure fairly exactly, and characteristic curves should be determined at a sufficient number of wavelengths to minimize the errors sufficiently. A simple error analysis is described. (Diss. Abstr. Int., B)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 19199 and 19213.

19241 (AD–758710) SOME ASPECTS OF COSMIC SYNCHROTRON SOURCES. Epstein, R. I. (Stanford Univ., Calif. Inst. for Plasma Research). Mar 1973. Contract N00014-67-A-0112-0062. 75p. (SU-IPR–435). NTIS.

In the earlier treatments of synchrotron theory it was usually assumed that the pitch angles of the radiating particles are of the order of unity and that the emission occurs at high harmonics of the fundamental frequency. In this investigation the authors have examined synchrotron radiation for some of the cases for which these assumptions are not applicable. Considered first is the synchrotron emission from individual particles which have small pitch angles, the general properties of synchrotron sources which mainly contain such particles, and the emissivities and degrees of circular polarization for specific source distributions. Then considered are several models for actual synchrotron sources. The limitation of synchrotron source models for optical pulsars and compact extragalactic objects are discussed and it is shown that several existing models for the pulsar NP 0532 are inconsistent with the measured time variations and polarizations of the optical emission. (NTIS)

19242 (N–73-18824) IDENTIFICATION OF THE X-RAY PULSAR IN HERCULES: A NEW OPTICAL PULSAR. Davidsen, A.; Henry, J. P.; Middleditch, J.; Smith, H. E. (California Univ., Berkeley). 1972. 14p. (NASA-CR–130923). NTIS.

A series of photographic, photoelectric, and spectroscopic observations beginning June 1, 1972 has led to the optical identification of Her X-1 (2U 1705 + 34), a pulsed x-ray source in an eclipsing binary system, with the thirteenth magnitude blue variable star HZ Herculis. The detection of optical pulses at the frequency of the x-ray pulsar on three nights makes the identification conclusive and establishes HZ Her as the second known optical pulsar. The strength of the optical pulses may be correlated with the orbital phase but is not obviously related to the high or low intensity states of the x-ray source. (STAR) (auth)

19243 (N–73-19864) LUMINOSITY FUNCTION OF QUASARS AND ITS EVOLUTION: A COMPARISON OF OPTICALLY SELECTED QUASARS AND QUASARS FOUND IN RADIO CATALOGS. Petrosian, V. (Stanford Univ., Calif. Inst. for Plasma Research). Inst. for Plasma Research).
Jan 1973. 48p. (NASA-CR–131111; SUIPR–502). NTIS.

The luminosity function of quasars and its evolution are discussed, based on comparison of available data on optically selected quasars and quasars found in radio catalogs. It is assumed that the redshift of quasars is cosmological and the results are expressed in the framework of the $\Lambda = 0$, $Q_{O=1}$ cosmological model. The predictions of various density evolution laws are compared with observations of an optically selected sample of quasars and quasar samples from radio catalogs. The differences between the optical luminosity functions, the redshift distributions, and the radio to optical luminosity ratios of optically selected quasars and radio quasars rule out luminosity functions where there is complete absence of correlation between radio and optical luminosities. These differences also imply that Schmidt's (1970) luminosity function, where there exists a statistical correlation between radio and optical luminosities, although it may be correct for high redshift objects, disagrees with observation at low redshifts. These differences can be accounted for by postulating existence of two classes (1 and 2) of objects. (STAR) (auth)

19244 COSMIC X-RAY SOURCES: A PROGRESS REPORT. Friedman, H. (Naval Research Lab., Washington, DC). Science; 181: No. 4098, 395–407(3 Aug 1973).

The present knowledge of discrete x-ray sources is reviewed, a few examples are treated in some detail, and the importance of discrete and diffuse contributions to the background is estimated. (WDM)

19245 OPTICAL APPEARANCE OF BINARY X-RAY SOURCES. Pringle, J. E. (Sussex Univ., Brighton, Eng.). Nature (London) Phys. Sci.; 243: No. 128, 90–94(11 Jun 1973).

The expected optical behavior of binary x-ray sources is considered with reference to their optical identification. The system Hercules X-1 is studied in some detail, in particular the 35 d period and optical pulses. A model is proposed for transient x-ray sources. (auth)

19246 35-DAY PERIODICITY OF HERCULES X-1. McCray, R. (Univ. of Colorado, Boulder). Nature (London) Phys. Sci.; 243: No. 128, 94–96(11 Jun 1973).

It is stated that the model of a rapidly rotating magnetised neutron star in orbit about the companion star HZ Herculis appears to provide a coherent explanation for the 1.245 pulsation period and for the 1.7d eclipse period, but the 35d cycle remains enigmatic. It is suggested here that the 35d cycle is caused by a nearly periodic regulation of the accretion gas flow presumed to be the source of the x-ray luminosity of Hercules X-1; this model follows naturally from the familiar concept of a semi-detached binary system, in which HZ Herculis is slowly spilling matter into the magnetized neutron star Hercules X-1. The model explains not only the mechanism for the 35d periodicity, but also phase-locking of the 35d cycle to the 1.7d orbital period, together with some details of the profile of the cycle and the x-ray spectral changes within the cycle. The essential regulating mechanism of the gas flow is radiation pressure, and this is discussed. The phase-locking of the 35d cycle to the 1.7d orbital period might be understood if a slight eccentricity in the binary orbit is postulated. and a possible check for this is suggested. Another mechanism that might couple into the regulating mechanism described is the effect of x rays on the atmosphere for HZ Herculis. An observational test is suggested that might shed additional light on the phenomenon of accretion. (UK)

19247 FLUX DENSITY OF OH471 BETWEEN 1963 AND 1970. Kraus, J. D.; Gearhart, M. R.; Ehman, J. R. (Ohio State Univ., Columbus). Nature (London) Phys. Sci.; 243: No. 128, 94(11 Jun 1973).

It is stated that a redshift of 3.4 has been reported for OH 471, and that its radio spectrum is of the CE (centimeter excess) type. There is a strong probability that such sources will prove to be variable, and it was considered to be of interest to look for any signs of variability in OH 471. The archives of the OSU Radio Observatory were analysed for flux densities; these archives contain many records of OH 471 at 1415 MHz as far back as 1963, in addition to records at 612 and 2650 MHz for later epochs. The results could be interpreted as indicating no significant change in flux density over the period 1963 to 1970; on the other hand they could be interpreted as indicating some decrease over that period. Thus, although there is not convincing evidence of variability of OH 471, the possibility cannot be ruled out and it will be of interest to continue to monitor this object. The flux density at 2650 MHz was found to be 1.3 ± 0.4 fu and at 612 MHz 1.1 ± 0.4 fu. (UK)

19248 CONTINUUM RADIO EMISSION FROM THE VICINITY OF PULSARS. Schoenhardt, R. E. Nature (London) Phys. Sci.; 243: No. 126, 62–63(28 May 1973).

The possibility has been suggested of the existence of weak radio haloes around old pulsars, and an attempt has been made to explain the peculiar nonthermal shell source near PSR 1919 + 21

in this way. Observations aimed at the detection of weak radio emission from the surroundings of pulsars are described, made with the 100m radiotelescope of the Max-Planck Institute, Bonn, between September 1972 and March 1973. An area of about one square degree, centered on the relevant pulsar, was observed for 18 pulsars, in addition to a small field around PSR 0611 + 22 believed to be associated with the supernova resonant 1C 443. Maps are shown of the surroundings of the 19 pulsars. No object similar to the shell source G 55.7 + 3.4 near PSR 1919 + 21 was found in the vicinity of any of the observed pulsars, and for almost all of these pulsars only point sources were detected in the surroundings, the only exception being PSR 0611 + 22, where there is the neighboring supernova remnant 1C 443, and possibly PSR 0138 + 59, where a very weak extended source was observed; the existence of the latter, however, needs to be confirmed by more observations. A small area around PSR 0611 + 22 was observed for a longer time, and the results suggest that the pulsar has blown out a cavity around itself. PSR 0611 + 22 may be a runaway pulsar that originated from a binary system. If association of this pulsar with IC 443 is assumed then the present observations suggest that it has determined the peculiar shape of the western edge of IC 443 and created a cavity by means of its radiation pressure. The results presented suggest that pulsars are not generally surrounded by haloes, or else that such haloes are extremely weak radio sources. (UK)

19249 EXPANDING-SOURCE MODEL OF RADIO OUTBURSTS IN QSS AND IN NUCLEI OF SEYFERT GALAXIES. Kogure, T. (Ibaraki Univ., Mito, Japan). Publ. Astron. Soc. Jap.; 23: No. 4, 449-465(1971).

The radio outbursts which occurred in 3C120, 3C273, and 3C279 in 1966–1967 are considered under the revised expanding-source model of Van der Laan (1966) type, in which the energy supply in the form of amplification of magnetic field and acceleration of electrons is taken into account. The model parameters are first derived from the observed data as a function of the expanding velocity taken as a free parameter, and then the models are determined on the assumption that the energy equipartition is established between the cosmic-ray particles and the magnetic field in the source at the initial phase. The models so obtained are characterized, for the outbursts of 3C120 and 3C273, as smaller initial size (0.1 to 0.03 pc), stronger initial magnetic field (10 to 20 gauss) and high expanding velocity (0.3 to 0.6 c) as compared with the original model of Van der Laan (1966). The energy requirement is $\sim 10^{52}$ erg for 3C120 (Seyfert galaxy) and $\sim 10^{54}$ erg for 3C273 (QSO). For the outburst of 3C279, an equipartition solution is not obtained. It is pointed out, as a result, that the outbursts are generally not the remnant phenomena of some primeval explosion as has hitherto been assumed, but are the phenomena of an explosion in which the energy supply is still continuing. The effect of ionized gas is also examined with respect to two points for the nuclei of Seyfert galaxies. It is found that (i) the radio outbursts cannot be interpreted as being the effect of free–free absorption of ionized gas inside the source, and (ii) the expanding radio sources can hardly be embedded inside the ionized-gas components of the Seyfert nuclei, unless the ionized gas is concentrated into separate clouds so as to reduce the effective optical depth for radio waves. (auth)

19250 PHYSICAL STATE AND STABILITY OF SUPER-MASSIVE OBJECTS. Unno, W. (CSIRO, Sydney). Publ. Astron. Soc. Jap.; 23: No. 2, 123-147(1971).

Mechanical and thermal properties of super-massive objects ($M > 10^3 M_\odot$) were studied in an attempt to reveal some of the gross features of quasi-stellar objects. The objects are assumed to be composed of a homogeneous mixture of gas and stars. The stellar constituent is treated approximately like a continuous medium interacting with the gaseous constituent through the gravitational field as well as by direct interaction. The gaseous constituent is supported against large gravitational forces mainly by the thermal radiation pressure. (WDM)

19251 PROPAGATION OF AN INTENSE ELECTROMAGNETIC WAVE IN A PLASMA. Stewart, P. (Univ. of Manchester, Eng.). Lett. Nuovo Cim.; 7: No. 8, 310-312(23 Jun 1973).

In an attempt to understand the propagation of intense waves in a plasma the properties of a self-consistent solution of the nonlinear system formed by the Boltzmann equation for a species of electrons only and Maxwell's equations for a circularly polarized electromagnetic wave of constant amplitude were investigated. (WDM)

19252 NONGEODESIC RADIAL ACCRETION. Hwang, A. E.; Dykla, J. J. (Univ. of Texas, Austin). Nuovo Cim.; 15B: No. 2, 210-225(11 Jun 1973).

In view of the importance of accretion as an astrophysical process associated with the detection and observation of black holes, nongeodesic radial accretion in the Schwarzschild geometry was studied. The motion of the accreting matter was assumed to be such that an observer at infinity sees the particles fall at polynomial velocities. The existence of compression shock waves in large classes of fluids whose equations of state supply the nongravitational forces required to maintain such motions was demonstrated. (auth)

19253 COHERENT GYROMAGNETIC EMISSION AS A RADIATION MECHANISM. Melrose, D. B. (Australian National Univ., Canberra). Aust. J. Phys.; 26: No. 2, 229-247(Apr 1973).

The properties of coherent gyromagnetic emission of radiation which can escape from a source of astrophysical interest by a bi-Maxwellian distribution of nonrelativistic electrons (thermal velocities $\beta_{\perp 0}c$ and $\beta_{\|0}c$, and streaming velocity $\beta_s c$) are considered. It is found that: (1) Coherent emission occurs only for $\beta_{\perp 0}^2 \gtrsim \beta_{\|0}$, and only for a more extreme anisotropy for waves close to their cutoff frequencies. (2) Coherent emission in the x-mode at the second harmonic, i.e. at $\omega \approx 2\Omega_e > \omega_p$, is the dominant process except for $\beta_s > \omega_p^2/\Omega_e^2$ when coherent emission in the x-mode at the first harmonic, i.e. at $\omega \sim \Omega_e \gg \omega_p$, is possible and dominates. It is argued that these results are not strongly dependent on the choice of distribution function. It is pointed out that the use of the quasilinear equations can be justified in any astrophysical context but that the above properties apply even when the quasilinear treatment is not valid. Limitations imposed on the mechanism by the presence of absorption in the thermal plasma and by competing instabilities are shown to be relevant except for emission in the x-mode at the first harmonic. (auth)

19254 AUTOMATIC DYNAMIC SPECTRUM ANALYZER FOR VIDEO TAPE RECORDED SIGNALS. Ellis, G. R. (Univ. of Tasmania, Hobart, Australia). Aust. J. Phys.; 26: No. 2, 253-256(Apr 1973).

A time-expansion sweep frequency spectrum analyzer is described for signals in the 0 to 3 MHz frequency range. It is based on a standard video tape recorder used in the single frame replay mode. With a time-expansion ratio of 400 between the record time and replay time, a frequency resolution of 10 kHz together with a time resolution of 0 · 5 ms is realized. An example of the spectra of Jupiter radio bursts made with the analyzer is presented. (auth)

Solar Phenomena

Refer also to abstracts 19355, 19385, and 19430.

19255 (AD–757754) VARIABILITY OF INTENSITY RATIOS OF H TO He AND He TO C, N, O IN ENERGETIC SOLAR PARTICLE EVENTS. Van Allen, J. A.; Venkatarangan, P.; Venkatesan, D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Feb 1973. Contract N00014-68-A-0196-0003. 36p. NTIS.

Explorer 35 data on energetic solar particle events show that intensity ratios of H to He (p/α) and of He to Z ≥ 3 ions (α/M) in the sub-MeV specific energy range (epsilon ≥ 0.5 MeV/N) vary from event to event and more especially during the time history of individual events. Ranges of observed values are $10 < p/\alpha < 90$ and $3 < \alpha/M < 27$. The interpretation emphasizes two interplanetary propagation effects as principally responsible for the observed variability of the intensity ratios of the various ionic species: (a) differential diffusion and (b) changes in intensity and spectra caused by reflection of diffusing particles by propagating magnetic discontinuities. (auth)

19256 (AD-758194) SIMULTANEOUS SOLAR WIND OBSERVATIONS. Fougere, P. F. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 12 Jan 1973. 13p. NTIS.

Over 1200 hours of simultaneous, interplanetary, solar-wind data from the satellites Explorer 33 and 35 are compared statistically. It is concluded that the two satellites sense the same solar wind which is thus homogeneous over a distance scale of at least 140 R_E. There are, however, systematic differences that are significantly larger than the random differences. These systematic differences are very likely due to small but not negligible calibration errors. (auth)

19257 (AD–758199) RADIO FREQUENCY SPECTRUM OF THE SUN. Final Report, 1 February–31 July 1972. Maxwell, A. (Harvard Radio Astronomy Station, Fort Davis, Tex.). Oct 1972. Contract F19628-72-C-0143. 8p. (AFCRL-TR–73-90). NTIS.

The report covers research work on the spectral characteristics of radio bursts from the Sun. (NTIS)

19258 (AD-758280) SOLAR X-RAY SPECTROSCOPY AND OPTICAL LINE POLARIMETRY. Final Report, 1 July 1970–31 December 1972. Novick, R.; Angel, J. R. P.; Weisskopf, M. C.; Wolff, R. S. (Columbia Univ., New York. Columbia Astrophys-

ics Lab). Mar 1973. 25p. (CAL-1202; AFOSR-TR-73-525). NTIS.

An experiment was performed to measure the x-ray spectrum of the solar corona between 1.8 and 5.4 A. Panels of mosaic graphite crystals were used as dispersive elements and proportional counters as detectors. The spectrometer was carried aloft by an Aerobee rocket during quiescent solar conditions. The data have been analyzed to yield the solar spectrum as a function of wavelength, revealing both line and continuum emission. (auth) (NTIS)

19259 (AD-758769) ISOTOPIC COMPOSITION OF SOME METALS IN THE SUN. Hauge, O. (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 14 Sep 1972. 78p. (AFCRL-TR-73-130). NTIS.

Information on the isotopic composition of chemical elements in the Sun may be obtained by analysis of photospheric and sunspot spectra. It is shown that besides investigations performed on molecular lines, information on isotope abundances of some heavier elements may also be derived from atomic line studies. A discussion of the elements Tb, Sr, Sb, and Eu are described. Studies of the solar isotopic composition of Cu from analysis of Cu I lines in photospheric spectra and CuH lines in sunspot spectra are described. (NTIS)

19260 (AD-757898) SOLAR WIND INTERACTIONS. Final Report, 15 January 1970-15 January 1973. Dessler, A. J. (Rice Univ., Houston, Tex. Dept. of Space Science). 16 Jan 1973. Contract F19628-70-C-0184. 79p. (AFCRL-TR-73-61). NTIS.

The report summarizes the results of research carried out on solar wind interactions. Following a brief review of the knowledge of the solar wind-magnetosphere interaction the report describes contract-supported research in the following four categories: Solar Wind/Magnetosphere Interaction in the Magnetopause; Structure and Dynamics of the Magnetospheric Tail; Magnetosphere-Ionosphere Coupling; and Substorm Theory. The first two categories include both theory and satellite-data analysis; the last two include theory only. An attempt is made to evaluate the contribution of these results to the attainment of the theoretical-empirical framework necessary to devise a routine procedure for the prediction of geomagnetic activity, by means of satellite-monitoring of upstream solar-wind conditions and/or parameters in the magnetospheric tail. (NTIS)

19261 (AD-757899) SOLAR WIND INTERACTIONS. Appendix 1. Final Report, 15 January 1970-15 January 1973. Dessler, A. J. (Rice Univ., Houston, Tex. Dept. of Space Science). 16 Jan 1973. Contract F19628-70-C-0184. 23p. (AFCRL-TR-73-61-App-1). NTIS.

The document is a collection of journal articles representing the product of research on the study of solar-wind interactions. The papers are divided into four categories: The solar-wind interaction with the bow shock, the magnetopause, and the moon; The steady-state structure and dynamics of the magnetospheric tail; Magnetospheric convection, and the dynamic interaction between the magnetosphere and the ionosphere through the flow of Birkeland currents; and The theory of the magnetospheric substorm phenomenon. (auth) (NTIS)

19262 (CONF-700705-(Vol.1), pp 385-396) SATELLITE RECOVERED NUCLEAR EMULSION STUDY OF SOLAR CYCLE VARIATIONS IN TRAPPED PROTON FLUXES. Filz, R. C. (Air Force Cambridge Research Labs., Bedford, MA). 1970.

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Sixty independent satellite recoveries of nuclear emulsions spaced over the period 1961 to 1969 were utilized to study solar cycle variations in trapped proton fluxes. Measurements of both 55- and 115-MeV protons were performed. The atmospheric densities encountered by these protons dropped to a minimum in 1964 and returned to a maximum in 1969 with an amplitude of about 3. Calculations assuming a time invariant source and energy loss by ionization were in qualitative agreement with the experimental proton flux observations which also show an oscillation with an amplitude of about 3. Problems associated with overexposure of the emulsions were solved by underdevelopment. Ilford G-5 emulsions were used for quantitative measurements despite year long storage prior to exposure and month long delays prior to processing. Angular measurements performed on heavy nuclei on one exposure were consistent with that expected of cosmic radiation. A possibility of detecting trapped alpha particles may exist and plastic materials have been exposed for this purpose. (auth)

For abstracts of individual papers see: 19191, 19264-19269, and 19336.

19263 (ESRO-SP-74) HEOS-I SATELLITE. Some Preliminary Scientific Results. Proceedings of a Colloquium, Saclay, 21-23 April 1971. (European Space Research Organization, Paris (France)). Mar 1972. 107p. (In English and French). (CONF-710468-). Dep. NTIS (U. S. Sales Only) $7.50.

Separate abstracts were prepared for eight of the papers presented. (WDM)

19264 (ESRO-SP-74, pp 7-20) SOLAR PROTON EVENT OF 2 NOVEMBER 1969 AS PART OF A LONG-LIVED SEQUENCE OF PROTON FLARES. Gros, M. (CEN de Saclay, Gif-sur-Yvette, France). Engelmann, J.; Masse, P.; Barouch, E. Mar 1972.

Observations of the solar proton event of November 2, 1969, based on data from the HEOS-1 and ESRO-II satellites, are presented. The energy ranges covered are respectively 6 to 1500 and 26 to 400 MeV. (FR)

19265 (ESRO-SP-74, pp 21-34) REVIEW OF SOLAR PROTON EVENTS RECORDED ON BOARD THE HEOS-I SATELLITE DURING THE FIRST THREE MONTHS OF 1970. Gros, M.; Barouch, E.; Masse, P. (CEN de Saclay, Gif-sur-Yvette, France). Mar 1972. (In French).

During the first three months of 1970, the S-72 experiment on board the HEOS-1 satellite yielded results concerning a series of solar events during which protons having energies between 6 and 1500 MeV were detected, this experiment enabled the changes occurring in particle fluxes arriving in the vicinity of the Earth to be followed. An attempt was made to associate each enhancement in particle flux with a solar event. (FR)

19266 (ESRO-SP-74, pp 35-46) SOLAR ELECTRON EVENTS IN 1969 AND 1970. Mercier, J.-P. (CEN de Saclay, Gif-sur-Yvette, France); Raviart, A.; Treguer, L.; Dilworth, C.; Maccagni, D.; Perotti, F.; Tanzi, E. Mar 1972. (In French).

During its duration (December 1968-July 1970), the S-79 experiment on board the HEOS-I satellite recorded eleven electron flux increases above the 7-MeV level which were associated with solar activity. Comparison of the time variations of these flux increases with those obtained for protons led to a separation of the injection and propagation processes. Further comparison of the proton and electron fluxes observed on board the same satellite led to the derivation of a constant which is characteristic of particle acceleration by the Sun. (FR)

19267 (ESRO-SP-74, pp 51-64) TRANSPORT CHARACTERISTICS OF LOW-ENERGY SOLAR COSMIC RAYS. Balogh, A. (Imperial Coll., London). Mar 1972.

The problems of low-energy charged particle propagation in interplanetary space are discussed on the basis of two examples taken from measurements made by the S-24C experiment on board the HEOS-I satellite. The solar origin and large-scale propagation characteristics of protons associated with the solar particle event of January 24, 1969, were determined. The increase in the intensity of 1- to 13-MeV protons associated with an interplanetary shock on March 25, 1969, was studied. (FR)

19268 (ESRO-SP-74, pp 77-87) SOLAR WIND PARAMETERS OBTAINED WITH THE EUROPEAN SATELLITE HEOS-I FOR THE PERIOD 5 DECEMBER 1968 TO 8 APRIL 1970. Palmiotto, F. (Consiglio Nazionale delle Ricerche, Rome). Mar 1972.

The hourly averages of the basic solar wind parameters (bulk velocity, number density, most probable thermal velocity, and dynamical pressure) are presented. Each diagram shows the data corresponding to one solar rotation. (FR)

19269 (ESRO-SP-74, pp 89-101) S-58 SOLAR WIND ANGULAR MEASUREMENTS. Joukoff, A. A. (Univ. Libre, Brussels). Mar 1972.

Some specific results from the S-58 experiment, including event analysis with geomagnetic correlation and plasma flow pattern in the magnetosheath, are presented. (FR)

19270 (N-73-17843) MARCH 7, 1970 SOLAR ECLIPSE INVESTIGATION. Final Report. Accardo, C. A. (GCA Corp., Bedford, Mass. GCA Technology Div.). Oct 1972. Contract NASw-1993. 81p. (NASA-CR-130698; GCA-TR-72-1). NTIS.

Studies from rockets directed toward establishing the solar x-ray fluxes during the March 7, 1970 total eclipse over the North American continent are reported. A map of the eclipse path is presented. The measured absorption profiles for the residual x-rays are useful in establishing their contribution to the D and E region ionization during the eclipse. The studies were performed with two Nike-Apache payloads launched over Wallops Island, Virginia. In addition to three x-ray detectors in the 1 to 8A, 8 to 20A, and 44 to 60A bands, there were included in the payloads two additional experiments. These were an electric field experiment and an epithermal photoelectron experiment. The x-ray instrumentation, payload description, flight circumstances and finally, the x-ray

results obtained are described. The various computer codes employed for the purpose of reducing the telemetered data as well as the eclipse codes are included. (STAR) (auth)

19271 (N-73-17844) SOLAR NEUTRINOS AND THE INFLUENCES OF OPACITY, THERMAL INSTABILITY, ADDITIONAL NEUTRINO SOURCES, AND A CENTRAL BLACK HOLE ON SOLAR MODELS. Stothers, R. B.; Ezer, D. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). [1972]. 14p. (NASA-TM-X-68847). NTIS.

Significant quantities that affect the internal structure of the Sun are examined for factors that reduce the temperature near the Sun's center. The four factors discussed are: opacity, central black hole, thermal instability, and additional neutrino sources. (STAR)

19272 (N-73-18816) SHORT-DURATION SOLAR MICROWAVE BURSTS AND ASSOCIATED SOFT X-RAY EMISSION. Spangler, S. R. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Dec 1972. Contract N00014-68-A-0196-0003. 104p. (NASA-CR-130859). NTIS.

Thesis.

Two hundred and fifty-nine short-duration microwave (15.4 GHz) bursts which occurred during the period of January 1968 to March 1970 were correlated with possible soft x-ray (2 to 12 A) flares occurring simultaneously. Sixty-six percent of the microwave bursts which were observed during periods of soft x-ray data coverage had associated soft x-ray flares. A study of an index of impulsiveness of the microwave flares failed to show a separation of the events into subclasses which could be attributed to distinctly different physical mechanisms. A weak (0.43) correlation was found between the intensities of the microwave and x-ray flares. A very weak (0.15) and statistically questionable correlation was found between the total energy released in these two energy ranges. Two models for the electron acceleration mechanism are discussed. (STAR) (auth)

19273 ACCELERATION OF SOLAR WIND PROTONS AND HEAVY IONS. Benz, A. O. Ithaca, NY; Cornell Univ. (1973). 162p. University Microfilms Order No. 73-16,093.

Thesis (Ph.D.).

Variations in the solar wind's $^4He^{++}$ abundance (relative to hydrogen) are frequently observed at 1 AU (astronomical unit). They strongly indicate that some diffusive separation takes place. It is suggested that the most likely altitude for this to occur is the lower corona. To allow such separation, plasma physical relaxation processes other than particle interactions must not play a major role in the acceleration of the undisturbed solar wind. (TSS)

19274 TEMPERATURE IN SOLAR FLARES. Smith, E. P. (Univ. of Maryland, College Park). pp 2359-2368 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

Analyses of the chromospheric hydrogen and helium spectral lines in flares have been quite fruitful in suggesting electron temperatures by fitting temperature and density models. Studies of these lines in several flares suggest temperatures ranging from 7000 to 40,000 K, even within a given flare. That there is a very steep temperature rise is also predicated by the high temperatures derived for the coronal portion of flares from soft x-ray and ultraviolet satellite spectra. Ionization temperatures as high as 20MK (20×10^6K) have been determined by assuming that if lines from a given stage of ionization appear in any strength, then the temperature of the plasma is that corresponding to the temperature necessary to produce that ion. The energy spectra of the thermal protions of hard x-ray (7 to 210 keV) flares can be fit with temperatures comparable to those derived from soft x rays. Analyses of selected soft x-ray lines lead to values of the electron density several orders of magnitude greater than normal coronal densities. To be compatible with values of the emission measure, such high densities can only exist in a small fraction of the total volume affected by the flare. Threadlike hot dense regions pervading a larger, cooler and less dense volume may in fact occur in both the corona and chromosphere. (auth)

19275 TEMPERATURE OF THE SOLAR CORONA. Culhane, J. L. (University Coll., London). pp 2369-2383 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

Before spacecraft became available for coronal studies, plasma temperatures were estimated from a variety of ground-based observations. These included methods based on ionization theory, line width measurements, radio and radar measurements and the assumption of hydrostatic equilibrium to interpret the observed density gradient. The results at present available from these observations are discussed. Space instruments, operating in the uv and x-ray spectral ranges, are producing a great deal of new information about the corona. Observations in these wavelength ranges may be made on the disc without occultation and therefore much more of the corona may be examined. Plasma temperature may be estimated by measuring spectrum line ratios. Many suitable line pairs exist in the uv and x-ray wavelength ranges. The accuracy available with these methods is limited by uncertainties in instrument calibration and in the values of atomic parameters. The plasma temperature may also be measured by observing the x-ray continuum at short wavelengths. Results presently available from uv and x-ray observations are discussed. (auth)

19276 TWO MAXIMA OF THE XX CYCLE OF SOLAR ACTIVITY. Szymanski, W. Postepy Astron.; 21: No. 2, 145-147 (1973). (In Polish).

The 13-month consecutive averages give curves of solar activity much too smooth. Especially in the XX cycle the two equally high maxima which are observed vanished completely. The 7-month consecutive averages do not smear out this characteristic feature of the curve, and probably calculation of such averages may be preferred to the calculation of the 13-month averages. (auth)

19277 FINITE AMPLITUDE CONVECTION IN A COMPRESSIBLE MEDIUM. Van der Borght, R. (Monash Univ., Melbourne). Publ. Astron. Soc. Jap.; 23: No. 4, 539-551(1971).

A system of ordinary nonlinear differential equations, describing finite amplitude convection in a compressible medium, is derived using a variational principle first developed by Prigogine and Glansdorff (1964, 1965). It is shown that these equations reduce to well-known results in the incompressible nonlinear case and in the compressible linear one. (auth)

19278 CLOSE CONNECTION BETWEEN FLARE-GENERATED CORONAL AND INTERPLANETARY SHOCK WAVES. Pinter, S. Nature (London) Phys. Sci.; 243: No. 128, 96-97(11 Jun 1973).

The question is discussed as to whether flare-generated coronal shock waves, observed in the radio range as type II bursts, are capable of escaping into interplanetary space. It is shown that there is a very close relation between flare-generated coronal and interplanetary shock waves. A number of interplanetary shock waves were studied, whose fronts intersected detectors located on heliocentric space probes. These shock waves were always connected with flares, accompanied by type II radio bursts, and were decelerating waves. Comparison of the radial velocities of coronal shock waves, derived from the frequency drift of the type II radio bursts, with the initial velocities of the interplanetary shock waves, confirmed the close relationship. One of the fundamental problems of flare-generated interplanetary blast waves is stated to be determination of the energy which the flare feeds to the shock; this is computed to be 6×10^{30} ergs, for average parameter values. A mechanism whereby the coronal shock waves penetrate into interplanetary space is suggested. (UK)

19279 DIFFERENTIAL ROTATION OF CONVECTIVE SPHERICAL SHELLS. Yoshimura, H.; Kato, S. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 1, 57-73(1971).

It has been suggested that the solar differential rotation might be maintained by large scale convective motions, whose horizontal scales are much larger than that of supergranules. This possibility is examined by studying the characteristics of large scale convective motions in a differentially-rotating thin spherical shell. It is shown that in the presence of large scale convective motions the rotation of a spherical shell is essentially differential, because large scale convective motions have the characteristic of transporting angular momentum from one zone to another zone. Such transport of angular momentum can actually occur toward a zone of higher angular velocity of rotation from that of lower angular velocity of rotation (negative viscosity). The solar differential rotation can be explained naturally if the predominantly excited convective modes are those which divide the spherical shell into longitudinal parts by planes passing through the rotating axis in the case of uniform rotation (i.e., the convective modes specified by the associated Legendre polynomial P_n^n). (auth)

19280 EMISSION-LINE INTENSITIES OF THE Ca II ATOM FROM A FINITE ATMOSPHERE. Ishizawa, T. (Kyoto Univ.). Publ. Astron. Soc. Jap.; 23: No. 1, 75-97(1971).

The total intensities of the H, K, and infrared triplet lines of the Ca II atom emitted from a finite uniform plane-parallel atmosphere are calculated for electron temperatures between 4,000 and 20,000°K, for electron densities between 10^{10} cm^{-3} and

10^{12} cm^{-3}, and for optical thicknesses in the K line between 0.1 and 100. Comparisons of the calculated intensities with the solar observations show that the Ca II-line intensities may be used to determine the optical thickness and electron temperature of the emitting atmosphere for any assumed electron density. (WDM)

19281 METALLIC LINES IN THE LOWER CHROMOSPHERE OBSERVED AT PERUVIAN ECLIPSE. II. Interpretation of Chromospheric Excitations by Multi-Level Line Transfer. Tanaka, K. (Univ. of Tokyo, Mitaka, Japan). Publ. Astron. Soc. Jap.; 23: No. 2, 217-238(1971).

With a view to explaining the characteristics observed at the Peruvian eclipse, multi-level transfer problems were solved in cases of Fe I, Zr II, and V II with atomic models consisting of 7 to 10 levels and with radiative transitions from 5 to 9 levels. It was shown that for most lines, excitation temperatures at the optical depth of unity in the center of each line are represented by one curve which is very similar to the distribution of Holweger (1967). The excitation temperature departs upward from Holweger's (1967) distribution at the depths $\tau_0 < 1$, taking on a fish-bone appearance. In the cases of Zr II and V II, lines are found to be formed predominantly by the scattering of photospheric radiation. The excitation temperatures at such heights as can be observed in the eclipse turned out to agree well with those derived from flash analyses, and to be larger than the local electron temperature. In the case of Fe I, all lines are formed at the level of the temperature minimum or higher. Chromospheric excitations can be reproduced for weaker lines, but for stronger lines the temperature rise as observed in the flash could not be explained by such a uniform model as the Bilderberg Continuum Atmosphere. (auth)

19282 METALLIC LINES IN THE LOWER CHROMOSPHERE OBSERVED AT PERUVIAN ECLIPSE. I. Observational Results. Tanaka, K. (Univ. of Tokyo, Mitaka, Japan). Publ. Astron. Soc. Jap.; 23: No. 2, 185-216(1971).

The metallic lines in high dispersion (1.2 Å/mm) spectrograms taken by Hiei and Hirayama (1970) in the 1966 eclipse were analyzed in order to obtain the excitation temperature (T_{ex}) in the chromosphere. The eclipse curves and brightness distributions of optically-thick lines were examined. From the difference of height variations of line width of neutral and of ionized lines, it was concluded that the density of neutral atoms drops more rapidly at small heights than the density of ions. The optical thickness at the limb and the mean value of T_{ex} were determined from the eclipse curve. The chromospheric distribution of T_{ex} thus obtained was compared with the photospheric one, and it was found, as a whole, to be larger by 200 to 700°K than Holweger's (1967) distribution, especially for ionized lines. This enhancement of T_{ex} in the chromosphere for weak lines is analogous to the rare-earth emissions on the disk near the limb. For stronger lines, the value of T_{ex} is even larger than the photospheric value, thus suggesting their chromospheric origin. The abundance was obtained from optical thickness measurement. The results of the rare-earth elements are consistent with the photospheric values, while the abundance of iron is close to a coronal value. The brightness distributions of stronger lines showed a brightening toward greater heights, and this tendency was attributed to the effect of bright mottles. (auth)

19283 PHOTOSPHERIC MASS MOTIONS ASSOCIATED WITH A FLARE. Yoshimura, H.; Tanaka, K.; Shimizu, M.; Hiei, E. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 3, 443-448(1971).

Curved absorption lines were observed in a flare region. Curvatures of the lines are larger in the weaker lines than in the stronger lines, appearing large at an onset of the flare, and then gradually diminishing. These curved lines are interpreted by large-scale mass motions with a dimension of 10^4 km in the photosphere and low chromosphere. (auth)

19284 MAGNETOHYDRODYNAMIC WAVE-MODE COUPLING. Quantum Field-Theoretical Approach to Weakly Nonlinear Case with Application to Solar Coronal Heating. Kaburaki, O. (Tokyo Univ.); Uchida, Y. Publ. Astron. Soc. Jap.; 23: No. 3, 405-423 (1971).

The problem of nonlinear coupling of magnetohydrodynamic wave modes is discussed by the use of a quantum field-theoretical approach with the Hamiltonian formulation. The macroscopic Hamiltonian defined as the total energy of the system in the presence of the waves is expanded in powers of the wave amplitude. The wave field of the lowest order with respect to the amplitude is shown to be actually quantized into an aggregate of three kinds of noninteracting bosons, correctly corresponding to the linear theory in the conventional approach. By defining the interaction Hamiltonian for a weakly nonlinear coupling by the next lowest order terms, one can treat the problem in terms of the level population equation by using the transition probabilities calculated from the matrix element of this interaction Hamiltonian in quantum theory. Returning to the classical limit, these population equations reduce to the governing equations for the variation of spectral energy densities for each mode through the weakly nonlinear coupling. An application to solar coronal heating is given as an example of the problems of astrophysical interest. (auth)

19285 ORIGIN AND EVOLUTION OF COMETS. Everhart, E. (Univ. of Denver). pp 302-304 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

Based on exact calculation of more than a million perturbed orbits there is very strong and detailed evidence that the short period comets can originate from original near parabolic orbits of small inclination and original peripheria not far from Jupiter's orbit. (FR)

19286 REVISION OF INITIAL SIZE, MASS, AND ANGULAR MOMENTUM OF THE SOLAR NEBULA AND THE PROBLEM OF ITS ORIGIN. Levin, B. J. (Inst. of Physics of Rare Earths, Moscow). pp 341-360 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

An attempt is made to demonstrate that, in contrast to previous conclusions, a massive solar nebula is not only a possibility derived from conditions in the interstellar medium but also a necessity when derivations are made from the present state of the solar system. The accumulation of Uranus, Neptune, and Jupiter are discussed. A probable evolution model is proposed for the peripheral parts of the solar nebula. (FR)

19287 PERTURBING ASPECTS OF THE COMPANIONS OF BARNARD'S STAR. Black, D. C. (Ames Research Center, Moffett Field, CA). pp 336-339 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

The multiplanet system of Barnard's star is discussed with particular emphasis on the large relative inclinations (>40 deg) of the planetary orbits. Possible cosmogonic implications of this system are considered. (FR)

19288 EXPERIMENT AND OBSERVATION OF ISOTOPE AND ELEMENT SEPARATION IN A PLASMA WITH COSMICAL APPLICATIONS. Bonnevier, B. (Kungliga Tekniska Hoegskolan, Stockholm). pp 257-259 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

Some isotope and element separation processes involving both plasma and neutral states of matter are briefly reviewed. It is shown that the degree of separation obtained is very similar to that observed for noble gases abundant in the solar system. (FR)

19289 MEMORY OF EARLY MAGNETIC FIELDS IN CARBONACEOUS CHONDRITES. Brecher, A. (Univ. of California, San Diego, La Jolla). pp 260-273 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

Preliminary results of a systematic study of the natural remanent magnetization (NRM) in several carbonaceous chondrites (CC) are presented. Their implications, regarding the paleofield environment in which the CC accreted, are briefly discussed. A novel experimental technique was used, based on the memory effect of magnetic carriers. The magnetic memory thereby recovered is the hardest fraction of NRM, and provides a lower limit to the primordially acquired magnetization. The characteristic hardnesses of the memory exhibited by CC of types I, II, and III in alternating field (AF) demagnetization, are compared. The range of values for parameters such as specific remanence, dc coercivity, hysteresis, saturation remanence, and saturation magnetization is illustrated. The use of saturation remanence demagnetization spectra in establishing the magnetic type of a CC is highlighted. From a comparison of NRM behavior under AF demagnetization with that of laboratory partial thermoremanence (pTRM), paleomagnetic field intensities of the order of 1 Oe are estimated. The presence of chemical remanence (CRM) components in CC is demonstrated. The large anisotropy of susceptibility found in carbonaceous chondrites is indicative of strong alignment of magnetic grains. (FR)

19290 CHEMICAL CONSTRAINTS ON THE ORIGIN OF CHONDRULES IN ORDINARY CHONDRITES. Dodd, R. T. (Max-Planck Institut fuer Kernphysik, Heidelberg); Walter, L. S. pp 293-300 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

Chemical variations found among 61 chondrules from the Chainpur (LL-3) chondrite are compared with those predicted for various mechanisms of chondrule formation; neither crystal–liquid nor liquid–vapor fractionation accounts for the pattern of variation in Chainpur, which appears to reflect fragmentation of a crystalline precursor rock whose crystal dimensions were about $^1/_{10}$ of the median chondrule diameter. (FR)

19291 VAPORIZATION THEORY AND NON-GRAVITATIONAL. Delsemme, A. H. (Univ. of Toledo). pp 305-310 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

The very large gas productions that have been recently established for comets, rule out desorption models of the cometary nucleus and strongly support the vaporization of an icy conglomerate. The results are compared with the empirical dependence that can be derived from Marsden's recent work on comet Schwassmann–Wachmann II. The law, as deduced from this comet's observations, rules out the vaporization of all gases with high vapor pressure, like CO, CH_4, NH_3, etc., and even CO_2, but coincides surprisingly well with a vaporization controlled by the latent heat and vaporization rate of water, as would be the case for pure water ice or for solid hydrates of gases. The fact that the gas molecules encaged in the cavities of the solid hydrates would simply be liberated in proportion by the vaporization of their water, seems therefore to be confirmed by the present results. (FR)

19292 STRANGE CASE OF PALLAS. Whipple, F. L.; Lecar, M.; Franklin, F. A. (Smithsonian Astrophysical Observatory, Cambridge, MA). pp 312-319 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

Pallas has an orbital excentricity which is twice as large as the median value for asteroids and an inclination which is four times greater than the median value for asteroids. The possibility of Pallas having been formed by accretion from the solar nebula is discussed, these anomalies being taken into account. (FR)

19293 BODE'S LAW AND THE PREFERENCE FOR NEAR COMMENSURABILITY AMONG PAIRS OF ORBITAL PERIODS IN THE SOLAR SYSTEM. Dermott, S. F. (Univ. of Newcastle upon-Tyne, Eng.). pp 320-335 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

It is shown that the statistical significance of Bode's law is not great and that there is no compelling reason for believing that the distribution of planetary orbits is nonrandom. The distribution of orbital periods in the satellite systems of Jupiter and Saturn is, however, markedly nonrandom as these systems contain a large number of satellites in stable resonances. The tidal hypothesis may be able to account for all the observed features, including the satellite mass distribution, of these systems and the satellite system of Uranus, but there are serious problems associated with the formation and stability of the stable resonances and the dissipation of the tidal energy. Hypotheses, other than the tidal hypothesis, are also discussed. It would appear that the evolution of the major satellite systems may have been different from that of the planetary system. (FR)

19294 MASS TRANSPORT IN THE MODEL OF SOLAR NEBULA BY A. G. W. CAMERON. Safronov, V. S. (Inst. of Physics of Rare Earths, Moscow). pp 361-366 of Origin of the Solar System. Reeves, H. (ed.). Paris; Centre National de la Recherche Scientifique (1972).

From symposium on the origin of the solar system; Nice, France (3 Apr 1972).

The rate of transport of material in the solar nebula due to turbulence induced by convection parallel to the axis of rotation as it was suggested by A. G. W. Cameron is calculated. It is found that the time of appreciable redistribution of the mass in the nebula is two orders of magnitude longer than the time of cooling of the nebula. It is thought that the same difficulty appears also in a new hypothesis by Cameron and Pine on the angular momentum transport by meridional circulation currents. (FR)

19295 CORONAL IDENTIFICATIONS BELOW 400 A. Widing, K. G. (Naval Research Lab., Washington, DC). Nucl. Instrum. Methods; 110: 361-371(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

The permitted line spectrum of the average corona at a typical temperature in the range of one to two million degrees falls in two main wavelength regions: 40–100Å for $\Delta n = 1$ transitions, and 170–400Å for $\Delta n = 0$ transitions. Active regions in the corona localized over sunspots produce a hotter, variable spectrum which lies predominantly below 20Å, characterized by the emission of helium-like ions. Solar flares produce a transient spectrum of highly stripped iron below 14Å. Remaining identification problems in the corona largely concern the spectra of iron in all its ion stages. Laboratory analysis of Fe IV–VII, and observation of these ions on the sharp, inner face of the corona; identification of 3p–4s, 4d and 3d–4f transitions of Fe and Ni between 50 and 100Å; identification of the solar flare iron line emission between 10 and 14Å with the corresponding ion stages XIX through XXIV. Although identification of the solar abundant elements from C to Ni in the coronal spectrum is well advanced, detection of elements with solar abundance less than 10^{-6} (relative to hydrogen) is very incomplete. (auth)

19296 FORBIDDEN LINES IN SPECTRA OF THE SOLAR CHROMOSPHERE AND CORONA. Jordan, C. (Culham Lab., Abingdon, Eng.). Nucl. Instrum. Methods; 110: 373-379(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

A review is given of the types of forbidden transitions which are observed in the spectrum of the solar chromosphere and corona. The importance of determinations of the lifetimes of the metastable levels from which the forbidden lines originate is discussed. The use of selected relative intensities for spectroscopic measurements of electron density is described. (auth)

19297 SOLAR NEUTRINO PROBLEM. Bahcall, J. N. (Princeton Univ., NJ). Nucl. Instrum. Methods; 110: 381-384 (1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

The problem of accounting for the discrepancy between the observed upper limit of the solar neutrino flux and that which can be calculated is explored in detail, but not resolved. A number of possible solutions to the problem are mentioned. (auth)

19298 OSCILLATOR STRENGTHS OF ASTROPHYSICAL INTEREST FROM LIFETIME DATA. Smith, P. L. (California Inst. of Tech., Pasadena). Nucl. Instrum. Methods; 110: 395-403 (1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

Determination of absolute oscillator strengths from lifetime data would be of value in the quantitative interpretation of astrophysical spectra. A survey of f-values needed for solar abundance calculations will be presented. If the lifetime of a level is known, absolute f-values can be determined by measurement of the relative intensities of the lines from that level. The details of such relative intensity measurements will be discussed with emphasis on the requirements for the source and on the calibration of the relative detection efficiency of the spectrometer. (auth)

19299 CHARACTERISTICS OF COSMIC-RAY VARIATIONS NEAR THE SOLAR EQUATORIAL PLANE. Dorman, L. I.; Kaminer, N. S.; Kuz'micheva, A. E. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 963-964(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1112(1972).

It is concluded that a decrease in the amplitude of the intensity increases, A, preceding Forbush decreases by an amount $\delta A = 11\%$ should be expected near the solar equatorial plane. During 1964-69, 37 cases of Forbush decreases were selected. In six of these cases, the Earth's solar latitude was $\varphi \geq 2°$. For these six cases, the average amplitude of A = 0.90%, and for the remaining 31 cases A = 1.06%. Hence, $\delta A \approx 15\%$. (WDM)

19300 TIME DEPENDENCE OF COSMIC-RAY INTENSITY AT THE ANISOTROPIC STAGE OF SOLAR FLARES. Toptygin, I. N. (Leningrad Polytechnical Inst.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 860-865(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 989-995(1972).

Solutions of the nonstationary kinematic equation are obtained in the approximation of small angles. The time dependence of particle density is computed for the initial stage of a flare at distances from the source smaller than the mean free path. It is demonstrated that at these distances the anisotropy of the flux of particles of given energy may change sign twice during a sufficiently

short flare. Measurement of the period of these anisotropy fluctuations for particles of various energies can yield information on the magnitude of the transport mean free path and on its energy dependence. (auth)

19301 SOLAR RADIO BURST ACTIVITY INDEX (I b) AND THE BURST INCIDENCE (B i) FOR 1968–1969. Basu, D. (Univ. Mackenzie, Sao Paulo, Brazil). Rev. Brasil. Fis.; 1: No. 2, 297-302(Oct 1971).

Daily values of the solar radio burst activity index (I_b) and of the burst incidence (B_i), as defined in the text, are computed for the period 1968–1969 at the frequencies 8800, 4995, 2695, 1415, and 606 MHz from data collected at Sagamore Hill and Manila. Due to their geographical position, these two observations provide almost continuous coverage of the sun with similar equipment. Characteristics of I_b and B_i at different frequencies corresponding to different levels in the solar atmosphere are discussed. (auth)

Galaxies

Refer also to abstract 19249.

19302 (AD–757687) APERTURE SYNTHESIS OF INTERSTELLAR NEUTRAL HYDROGEN IN ABSORPTION. I. Perseus Arm Feature of Cassiopeia A. Greisen, E. W. (Owens Valley Radio Observatory, Pasadena, Calif.). 1973. Contract N00014-67-A-0094-0019. 42p. NTIS.

The Owens Valley Radio Observatory interferometer was used to carry out a program of aperture synthesis in the interstellar neutral hydrogen absorption line. Maps having resolutions of 0.2 km/s and about 1.3 arc minutes were produced using a novel Fourier inversion method. This paper is devoted to discussions of the observing and analyzing procedures and of the results for the Perseus arm feature in the spectrum of Cassiopeia A. (NTIS)

19303 (N–73-17847) STOCHASTIC MODEL OF THE GALACTIC MAGNETIC FIELD. Kaiser, T. B. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Sep 1972. 25p. (NASA-CR–130158). NTIS.

Existing stochastic models of the galactic magnetic field are considered and found to suffer certain defects. A new model is proposed which overcomes faults of the previous theories while retaining their strengths. (STAR) (auth)

19304 (N–73-18819) GAMMA RAY EMISSION FROM THE REGION OF THE GALACTIC CENTER. Cosmic Physics Report. Dahlbacka, G. H.; Freier, P. S.; Waddington, C. J. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Sep 1972. Contract N00014-67-A-0113-0021. 23p. (NASA-CR–130863). NTIS.

A combination nuclear emulsion–spark chamber gamma-ray (E = 100 MeV) telescope was used to study the region of sky that includes the galactic center. 95% confidence upper limits on the flux from the reported sources G γ 2–3 and Sgr γ-1 were placed at 4.4 and 8.8×10^{-5} protons/cm^2-sec and a similar limit on the emission from the galactic center as a point source (±0.75°) was placed at 3.3×10^{-5} protons/cm^2-sec. No enhanced emission was observed from the galactic plane (±6°) and an upper limit of 2×10^{-4} protons/cm^2-sec/rad was obtained. (STAR) (auth)

19305 BERKELEY LOW-LATITUDE SURVEY OF NEUTRAL HYDROGEN. Part I. Profiles. Weaver, H.; Williams, D. R. W. (Univ. of California, Berkeley). Astron. Astrophys., Suppl. Ser.; 8: 1-503(Jan 1973).

38,961 H I profiles covering the galactic zone –10° to +10° between the longitude limits l = 10° to 250° are presented. The observing program, the accuracy of telescope pointing and receiver calibration, and the principles of data reduction are discussed in some detail. (auth)

19306 STUDIES OF FOUR REGIONS FOR USE AS STANDARDS IN 21 cm OBSERVATIONS. Williams, D. R. W. (Univ. of California, Berkeley). Astron. Astrophys., Suppl. Ser.; 8: 505-516 (Jan 1973).

Four 21-cm regions including three I.A.U. recommended standards were studied for suitability as standard regions. Maps are presented of the regions of both peak temperatures and integrated intensity. Correction curves are given to convert the measured antenna temperature into the more meaningful brightness temperature. These curves were derived using detailed measurements of the 85-foot telescope antenna pattern and assuming source brightness distributions of simple form. (auth)

19307 SURVEY OF NEUTRAL HYDROGEN IN LOW GALACTIC LATITUDES BETWEEN l = 356° AND 24°. II. Atlas of 21 cm Hydrogen-line Profiles and Contour Maps. Simmonson, S. C. III.; Sancis, R. (Leiden Univ.). Astron. Astrophys., Suppl. Ser.; 10: No. 3, 283-364(Jun 1973).

Observations in the 21 cm line of neutral hydrogen were made with the Dwingeloo 25 m radio telescope at a resolution of 16 kHz on a 0.5 grid over the region l = 356 to 2°, b = 0° to + 5°, l = 2 to 10°, b = 0°; and l = 10 to 24°, b = –8° or –6° to + 5°. The observations are presented individually as hydrogen-line profiles (part IX of the "Dwingeloo Atlas of 21 cm profiles") and collectively as contour maps of brightness temperature in l,V and b,V coordinates. (auth)

19308 OPEN CLUSTER COLLINDER 107 AND A STELLAR RING IN MONOCEROS. Isserstedt, J.; Schmidt-Kaler, T. (Univ., Bochum, Ger.). Astron. Astrophys., Suppl. Ser.; 10: No. 3, 365-383(Jun 1973). (In German).

A star field of 60′ diameter within the OB aggregate Mon OBI, centered on the inconspicuous open cluster Collinder 107, and containing a stellar ring, is investigated by photographic UBV photometry and low dispersion spectral classification. The field shows heavy reddening with strong variations. Most of the early type stars with $V \leq 13.0$ are concentrated at a distance of 1.66 kpc, in Collinder's cluster region as well as in the rest of the field. Star numbers do not show any concentration in the cluster region: there is no difference between cluster and field as far as proper motions and radial velocities are concerned. It is concluded that Collinder 107 is not a cluster but part of a spiral filament. The color–magnitude diagram V vs. U–B of the stellar ring appears to be different from that of the immediately surrounding field. The individually absorption corrected color–magnitude diagram is similar to that of young open clusters. The two most luminous members have spectral types OB$^+$ and BO III. The distance of 1.74 kpc applies to all stars with $(B-V)_0 \leq +0.20$. It corresponds to a minor diameter of the stellar ring of 7.2 pc in agreement with earlier results. However, it cannot be completely excluded that the ring is an accidental configuration of stars at a common distance in a nearby spiral filament. (auth)

19309 MAGELLANIC CLOUDS. Symposium Held at Santiago, Chile, March 28–29, 1969. Muller, A. B. (ed.). Astrophysics and Space Science Library. Volume 23. Dordrecht, Netherlands; D. Reidel Publishing Company (1971). 200p. (CONF-690353–). f 44.–.

Twenty-five papers are included in this volume including review papers, contributions on the current observational and theoretical approaches, and some papers indicating the prospects for future work. (WDM)

19310 SPECTRA OF SEVEN COMPACT GALAXIES. Kodaira, K. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 4, 589-591(1971).

Spectroscopic observations of seven compact galaxies are reported. Two of these show sharp emission lines superposed on F-type spectra, one shows a featureless continuum, and one has an A-type spectrum without emission lines, while the other three show G-type spectra. (auth)

19311 ANOMALOUS HELIUM ABUNDANCE OF THE GALACTIC CENTER H2 REGION G0.5–0.0. Huchtmeier, W. K.; Batchelor, R. A. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Nature (London); 243: No. 5403, 155-156(18 May 1973).

An unsuccessful attempt was made to detect the He 109 α line from the galactic center H II region G 0.5–0.0. This failure set an upper limit to the He abundance, which was about 10% of that found in many H II regions. The observations were carried out in October 1972 using the Parkes 64 m radio telescope. Details are given of the experimental technique, and the assumptions made, and results are discussed. It seems that the galactic center H II regions are deficient in He—a characteristic shared with many halo Bp stars and some QSOs. So far no theory simultaneously accounts for a He abundance of about 0.1 in astronomical objects and He-deficient regions such as G 0.5–0.0. (UK)

19312 CIRCULAR POLARIZATION BY SINGLE SCATTERING OF UNPOLARIZED LIGHT FROM LOSS-LESS, NON-SPHERICAL PARTICLES. Bandermann, L. W.; Kemp, J. C. (Univ. of Hawaii, Honolulu). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 367-377 (1973).

Elliptically polarized light can be obtained by scattering of unpolarized light from loss-less (real reflective index n), non-spherical particles whose dimensions are not necessarily small compared with a wavelength. Such a particle is represented by a finite or infinite number of Rayleigh spheres and approximate expressions are derived for the total scattered intensity I and for the circularly polarized component, V. Elongated particles give a polarization with an angular dependence similar to that for the absorbing Rayleigh ellipsoids investigated by Thomas Schmidt

(I.A.U. Symposium No. 52.(1972)). However, the fractional circular polarization, q = V/I, depends on wavelength λ in a manner varying with particle size. If $n-1 \ll 1$, and if the thickness of such a particle is $d \ll \lambda/2\pi$, then $q \lesssim 20(n-1)d^2\lambda^{-2}$. (auth)

19313 ENERGY AND ANGULAR MOMENTUM EXCHANGES BETWEEN A DENSITY WAVE AND STARS AT LINDBLAD RESONANCES IN A DISK-LIKE STELLAR SYSTEM. Kato, S. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 4, 467-483(1971).

It is known that density waves in a rotating disk-like collisionless stellar system have resonant interactions with stars at places of so-called Lindblad resonance. The energy and angular momentum exchanges between a wave and stars due to resonant interaction at Lindblad resonances is examined for mildly wound density waves, assuming the form of the perturbed gravitational potential. The results show that energy and/or angular momentum are transferred to a density wave from resonant stars, if a certain condition is satisfied. The possibility of the maintenance of spiral waves in disk-like galaxies by this process of energy and angular momentum exchanges with stars is discussed. (auth)

19314 ROLLING MOTIONS OF INTERSTELLAR GAS IN THE GALAXY. I. Fujimoto, M.; Tanahashi, Y. (Nagoya Univ., Japan). Publ. Astron. Soc. Jap.; 23: No. 1, 7-12(1971).

By making use of the λ21-cm line survey of the galactic plane by Westerhout (1966), a rolling motion of neutral hydrogen gas has been found along the nearest, Perseus, and distant arms in the galactic longitude range $l = 50°$ to $195°$ at $|b| \leq 1°$. The sense of the rolling motion around an arm changes from place to place with a typical scale of 300 pc or more along the identical arm. The velocity of the observed rolling motion takes a value of several km/sec near the arm surface, compatible with an early theoretical study. Some large rolling motions have been found locally at $l = 110$ to $119°$ and $l = 160$ to $170°$ in the nearest arm, $l = 50$ to $60°$ and $l = 95$ to $110°$ in the Perseus arm, and $l = 130$ to $150°$ in the distant arm. The kinetic energy of the local large rolling motion is about 10^{51} to 10^{52} ergs, which amounts to, if it is compared with other known energy release, a total kinetic energy of one Type II supernova explosion. (auth)

19315 ROLLING MOTIONS OF INTERSTELLAR GAS IN THE GALAXY. II. Fujimoto, M.; Tanahashi, Y. (Nagoya Univ., Japan). Publ. Astron. Soc. Jap.; 23: No. 1, 13-19(1971).

Free precession of a thin self-gravitating disk of continuous medium is investigated. Lynden-Bell's (1964) suggestions that the observed bending of the outer parts of galactic plane can be accounted for by a free precession of the Galaxy are confirmed. A large-scale noncircular motion is generated for the gas at a vertical distance from the galactic equatorial plane. It is in the plane perpendicular to δΩ and is nearly parallel to the galactic plane, where δΩ is the momentary component of the angular velocity of the precessing system in the direction perpendicular to the Galaxy's axis of symmetry. The directions of the noncircular motion are opposite above and below the galactic plane. If the gaseous spiral arm is due to a local strong concentration of the gas with such a non-circular motion, it will roll around its own axis. (auth)

19316 SELF-GRAVITATING DISK-LIKE STELLAR SYSTEM. Miyamoto, M. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 1, 21-32(1971).

The velocity distribution of a self-gravitating and time-independent disk-like stellar system is investigated for a plausible mass distribution (Toomre's [1963] model I), by expanding the distribution function for brevity in a finite double power series with respect to the energy and angular momentum of a particle. The study is free from assumptions of an ellipsoidal velocity distribution and of small peculiar velocities. However, the particular case is considered in which the functional form of the rotational velocity of the stellar disk is identical with that in the centrifugal equilibrium of the disk except for a constant numerical factor. The results show that in a class of distribution functions, the equi-frequency contours for low peculiar velocities are almost elliptical at large radial distances from the center of the disk. The axial ratio of such elliptical contours is nearly equal to $\sqrt{B/(B-A)}$, where A and B are Oort's constants. However, the ratio of the radial and azimuthal velocity dispersions, which are defined by considering stars with high peculiar velocities as well, deviates remarkably from $\sqrt{B/(B-A)}$. It is noticed that the radial velocity dispersion in the present models obeys a relation similar to a polytropic one with index 3. (auth)

19317 LARGE MAGELLANIC CLOUD. 2nd List of L.M.C. Members and List of Galactic Stars. Fehrenbach, C.; Duflot, M. (Observatory, Marseille). Astron. Astrophys., Suppl. Ser.; 10: No. 2, 231-265(May 1973). (In French).

Two new lists of stars in the direction of the Large Magellanic Cloud are presented. 88 of the first list are Large Magellanic Cloud members and 253 of the second list are galactic stars. (auth)

19318 EVAPORATION OF DIRTY ICE PARTICLES SURROUNDING EARLY TYPE STARS. II. The Orion Association. Isobe, S. (Univ. of Tokyo, Mitaka, Japan). Publ. Astron. Soc. Jap.; 23: No. 3, 371-386(1971).

The evaporation processes and the radiative segregation of ice particles surrounding early type stars are calculated. Owing to the fact that the imaginary part of the refractive index of ice particles is small at wavelengths longer than about 1500 Å, the effectiveness of these processes changes markedly according as the central-star temperature is higher or lower than 2.0×10^4K. The distances from the central stars, where the grains evaporate, are found to depend sensitively on the temperature of the central stars and on the grain size. If the density distribution of the circumstellar grains is assumed to be that of the hydrogen atoms, the ratio of total to selective absorption, $R = A_V/E_{B-V}$, on the line of sight is larger for the central star with a temperature higher than 2.0×10^4K than that with a lower temperature because of the effect of differential evaporation. The size redistribution by evaporation of grains is effective in the initial stage, but the size redistribution by radiation pressure of the central star is effective in later stages. The amount and the size distribution of the grains on the line of sight are changed more quickly by radiation pressure of the central star, with a temperature higher than 2.0×10^4K, than that with a lower temperature. The value of R is increased because of the effect of differential evaporation, then is decreased because of the effect of radiation pressure, while the amount of absorption on the line of sight is decreased by both effects. The ice particle model for dust grains discussed is justified by the following observational evidence, found in the Orion Association. That is: (1) The values of R are large for B-type stars and are small for A-type stars; (2) the values of R for B-type stars are larger in the regions including bright emission nebulae than in the other regions; (3) in the Orion Association for fraction of stars, which have a color excess greater than 0.40 magnitude, is small for B-type stars and is large for A-type stars. (auth)

19319 JEANS-TYPE CRITERION IN AN ISOTHERMALLY CONTRACTING TURBULENT GAS SPHERE. Sasao, T. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 3, 433-436(1971).

Jeans-type criterion in an isothermally-contracting turbulent medium is obtained according to Chandrasekhar's (1951) procedure. (auth)

19320 INSTABILITY OF A COMBINED SYSTEM OF STARS AND GAS UNDER THE INFLUENCE OF THE CORIOLIS FORCE. Niimi, H. (Kyoto Univ.). Publ. Astron. Soc. Jap.; 23: No. 2, 149-157(1971).

The instability of an infinite homogeneous system of stars and gas with uniform rotation is studied by use of the collisionless Boltzmann equation for stars, and the gasdynamic and the polytropic equations for a gas, together with the Poisson equation. It is shown that in addition to the Jeans-type instability, there exists an instability due to an anisotropic velocity distribution of stars in the combined system. The condition for the latter instability of perturbations with long wavelength is not affected by the presence of gas, and is in complete agreement with Wu's (1968) result for a system of stars only. The instability of perturbations with short wavelength almost perpendicular to the axis of rotation is also pointed out. (auth)

19321 INTERSTELLAR OBSCURATION IN THE DIRECTION OF MAFFEI 1 AND 2. Nandy, K.; Smriglio, F. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 25P-29P(1973).

Two infrared objects discovered by Maffei (Publ. Astr. Soc. Pacific; 80: 618 (1968)) near IC 1805 in the galactic plane have been identified as external galaxies. From extensive observations of the object Maffei I, the brighter of the two, Spinrad et al. (Astrophys. J.; 163, L 25 (1971)) concluded that it is a normal elliptical galaxy belonging to the local group. Whether or not Maffei I is a nearby elliptical galaxy belonging to the local group depends critically on the value of total absorption adopted when estimating its distance. As part of a general programme of the infrared survey of cool stars in different directions in the galactic plane, the variation of interstellar obscuration with distance has been re-examined. The visual obscuration A_v in the direction of Maffei I and 2 is found to be between 4 and 5 magnitude, implying that Maffei I is a member of the local group. (UK)

19322 SOLUTION BY CHARACTERISTICS AT FIXED TIME INTERVAL OF THE EQUATIONS OF ONE-DIMENSIONAL UNSTEADY FLOW. Chow, T. L. (California State Coll., Turlock).

J. Comput. Phys.; 12: No. 2, 153-170(Jun 1973).

The solution by characteristics at fixed time interval of the equations of one dimensional unsteady flow is presented. The new points are determined by initially fixing the time step and then the fluid characteristic is used to determine the spatial location of the points at the next time level. The results of the propagation of a strong radiative shock into a density gradient for which the method was designed are also included. (auth)

Cosmology

Refer also to abstract 20222.

19323 CORRELATING ARROWS OF TIME. Schulman, L. S. (Physics Department, Indiana University, Bloomington, Indiana 47401). Phys. Rev. D 7: No. 10, 2868-2874 (15 May 1973).

A thought experiment and some model systems are studied in an effort to examine the relation between the cosmological and thermodynamic arrows of time. Some doubt is cast on the hypothesis that the latter must follows the former. (auth)

19324 SCATTERING OF ELECTROMAGNETIC RADIATION FROM A BLACK HOLE. Mashhoon, Bahram (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 10, 2807-2814 (15 May 1973).

The problem of propagation of electromagnetic waves in a gravitational field can be reduced to the problem of wave propagation in a material medium in flat space-time. This method is used here to calculate the scattering cross section of a Schwarzschild black hole and the polarization of the scattered wave. It is shown that the polarization of the wave (as measured at infinity) is not affected by the presence of the spherically symmetric gravitational field of the black hole. The light scattered from a rotating or " live" black hole is, however, expected to be polarized for an incident unpolarized plane wave. This may offer a new way to detect a live black hole. (auth)

19325 MAXIMALLY SLICING A BLACK HOLE. Estabrook, Frank; Wahlquist, Hugo (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91103); Christensen, Steven; DeWitt, Bryce; Smarr, Larry; (and others). Phys. Rev. D 7: No. 10, 2814-2817 (15 May 1973).

Analytic and computer-derived solutions are presented of the problem of slicing the Schwarzschild geometry into asymptotically-flat, asymptotically-static, maximal spacelike hypersurfaces. The sequence of hypersurfaces advances forward in time in both halves ($u \geq 0$, $u \leq 0$) of the Kruskal diagram, tending asymptotically to the hypersurface $r = (3/2)M$ and avoiding the singularity at $r = 0$. Maximality is therefore a potentially useful condition to impose in obtaining computer solutions of Einstein's equations. (auth)

19326 CANONICAL QUANTIZATION OF A SPHERICALLY SYMMETRIC REAL KLEIN-GORDON FIELD IN THE CLOSED FRIEDMANN UNIVERSE. Vitello, A. P. Potsdam, NY; Clarkson Coll. of Tech. (1973). 68p. University Microfilms Order No. 73-14,854.

Thesis (Ph.D.).

The quantum constraints determining the state function for a system comprised of a gravitational field and a neutral Klein-Gordon field are obtained, and it is noted that the quadratic constraint is a special case of a very general Klein-Gordon type equation, which is presumably applicable to any system containing gravitational and matter fields. A scheme for interpreting a solution to this equation is presented which effectively parallels the treatment of special relativistic spin-zero bosons. A minisuperspace composed of a massless real Klein-Gordon field with vanishing spatial derivatives in a closed Friedmann universe is then considered and exact solutions are obtained for both the classical and quantum cases. However, the correspondence principle is found to be violated and the difficulty is ascribed to the presence of forbidden regions in the classical phase space. It is proposed that the conditions for applicability of the usual Poisson bracket to commutator quantization technique may be twofold: 1) Killing related coordinates, and 2) an unrestricted and nonredundant coordinate phase space. After obtaining a classical canonical frame satisfying these conditions, the usual quantization procedure produces a system which, in the proper limit, reproduces the classical results. In this system the square of the radius of the Friedmann universe and its intrinsic curvature are found to be operators (q-numbers) in contrast to the original system where these quantities were scalars (c-numbers). Also, an operator is displayed which gives rise to interaction terms (order $\hbar$) between the two degrees of freedom implied by the second order time derivative appearing in the quadratic constraint. The existence of such operators enhances the possibility that the added degree of freedom (a purely quantum phenomenon) will ultimately have observable consequences. The expectation value of the operator representing the intrinsic curvature of the universe goes singular at both the initial and final epochs. Unfortunately, the simplicity of the system precludes any definitive statements concerning the physical nature of these singularities. (Diss. Abstr. Int., B)

19327 GRAVITATION AND COSMOLOGY: PRINCIPLES AND APPLICATIONS OF THE GENERAL THEORY OF RELATIVITY. Weinberg, S. New York; John Wiley and Sons, Inc. (1972). 881p.

Topics covered include an historical introduction, special relativity, the principle of equivalence, tensor analysis, effects of gravitation, curvature, Einstein's field equations, classic tests of Einstein's theory, post-Newtonian celestial mechanics, gravitational radiation, stellar equilibrium and collapse, the action principle, symmetric spaces, cosmography, cosmology (the standard model), and cosmology (other models). (WDM)

19328 PLANE-SYMMETRIC COSMOLOGICAL MODEL 2. Singh, K. P.; Abdussattar (Banaras Hindu Univ., India). J. Phys., A (London); 6: No. 7, 1090-1096(Jul 1973).

Considering the cylindrically-symmetric metric of Marder (Proc. R. Soc. A.; 246: 133 (1958)) a plane-symmetric cosmological model has been derived which is of class higher than one. Various physical and geometrical properties of the model have been discussed. It is found that when the model is filled with disordered radiation it becomes conformal to flat space-time and reduces to a particular case of the Lemaitre Universe. (auth)

19329 SINGULARITIES IN GENERAL RELATIVITY AND COSMOLOGY. Klimek, Z. (Jagellonian Univ., Krakow). Postepy Astron.; 21: No. 2, 115-125(1973). (In Polish).

This article contains a review of problems connected with the definition of singularities in general relativity and with the conditions of their existence. (auth)

19330 ENERGY-MOMENTUM TENSOR FOR RADIATION AND RADIATIVE VISCOSITY. Masaki, I. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 23: No. 3, 425-431(1971).

The energy-momentum tensor for radiation in optically thick matter is calculated for the case in which the matter interacts with photons by the process of Thomson scattering as well as by the processes of absorption and emission of photons. The expression for the coefficient of radiative viscosity given in this energy-momentum tensor is a generalization of that derived by Thomas (1930), and reduces to his if the effect of the Thomson scattering is neglected. (auth)

19331 INTERGALACTIC GAS IN THE LOCAL GROUP OF GALAXIES. Chamaraux, P. (Observatoire de Paris, Meudon, France); Tadokoro, M. Publ. Astron. Soc. Jap.; 23: No. 1, 117-119(1971).

The intergalactic ionized gas in the groups and clusters of galaxies is considered. Assuming equipartition among several modes of energy in a system, and taking into account the gravitational potential between the intergalactic gas and the member galaxies, the following revised results for the Local Group are obtained: the mass of the intergalactic gas is nearly equal to the total mass of the member galaxies: $\rho \sim 4 \times 10^{-29}$ g/cm^3, $T \sim 5 \times 10^{6}$°K, and its average turbulent velocity $v \sim 50$ km/sec. If the intergalactic gas is in cloud-structure, the conditions are favorable to detect Hβ. (auth)

19332 PRE-GALACTIC MAGNETIC FIELDS AND COSMIC RAYS IN THE EXPANDING UNIVERSE. Matsuda, T.; Sato, H.; Takeda, H. (Kyoto Univ.). Publ. Astron. Soc. Jap.; 23: No. 1, 1-5(1971).

If it is assumed that there existed primordial turbulence of the photon gas and the plasma dragged along by it, it is concluded that magnetic fields were amplified by the turbulent dynamo mechanism. As photon viscosity played a predominant role before the decoupling time, the mass contained within the region of the amplified magnetic fields was about 10^{10} to 10^{11} $M_\odot$ at the decoupling time. The magnetized turbulence can accelerate cosmic rays, and these turbulent eddies may become galaxies afterwards. (auth)

19333 DYNAMICAL CONTRACTION OF ROTATING GASEOUS SPHEROIDS. Hara, T. (Kyoto Univ.); Nakazawa, K.; Matsuda, T. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 2, 460-478 (Feb 1973).

Gravitational collapse of a non-spherical gas cloud was investigated taking into account the effects of gas pressure and rotation, but not the effect of magnetic field. It was assumed that the cloud was axisymmetric with spheroidal equi-density surfaces and contracts isothermally. It was found that a rotating cloud finally attains a disk-like shape after several bouncing motions due to the centrifugal and pressure forces regardless of the initial conditions. Some cases without gas pressure were also worked out, in order to see the characteristics of the nonspherical gas dynamics. Ap-

plications of the results were made to astrophysical problems such as the rotation curve of galaxies and the formation of stars. (auth)

19334 EMPTY BUBBLE IN NONSTATIC COSMOLOGICAL MODELS. Sengupta, P. (Mississippi State Univ., State College). Stud. Univ. Babes-Bolyai, Ser. Phys.; 18: No. 1, 13-23(1973).

The equation for the line element in spherical symmetry is solved for two cases: (i) within the spherical cavity were $p = 0$ and $\rho = 0$ and (ii) outside the sphere where $p \neq 0$ and $\rho \neq 0$; it is assumed that the outside is in equilibrium with the empty cavity. (WDM)

Planetary Phenomena

Refer also to abstract 17871.

19335 (AD-757064) MAGNETOSPHERES OF THE OUTER PLANETS. Kennel, C. F. (California Univ., Los Angeles. Plasma Physics Group). May 1972. Contract N00014-69-A-0200-4023. 50p. (PPG-120). NTIS.

Scaling laws for possible outer planet magnetospheres are derived. These suggest that convection and its associated auroral effects will play a relatively smaller role than at Earth, and that there is a possibility that they could have significant radiation belts of energetic trapped particles. (auth) (NTIS)

19336 (ESRO-SP-74, pp 73-76) INTERPLANETARY MAGNETIC FIELD MEASUREMENTS. Sear, J. (Imperial Coll., London). Mar 1972.

Measurements of the interplanetary magnetic field were performed between December 1968 and April 1969, and between September 1969 and December 1969, on board the HEOS-I satellite. Its variation with the solar cycle was studied. (FR)

19337 RADIATION BELT DIFFUSION APPLIED TO JUPITER. Stansberry, K. G. Riverside, CA; Univ. of California (1972). 201p. University Microfilms Order No. 73-15,642.

Thesis (Ph.D.).

The electron and proton radiation belts of the planet Jupiter were studied. The theory of radial diffusion by violation of the third adiabatic invariant was used to predict a flux model for trapped electrons at Jupiter. The electron model was evaluated by comparing the measured values of Jupiter's decimeter flux density spectrum, equatorial strip scans, and degree of polarization with the values calculated using synchrotron radiation theory. The theory and data were also compared for systematic variations of the parameters that define the electron model. A flux model for trapped protons at Jupiter was predicted using assumptions consistent with the electron assumptions and results. Radial diffusion of trapped electrons originating in the solar wind can generate a radiation belt that explains the decimetric radio emission from Jupiter. The predicted electron flux model has a peak flux of 1.6×10^9 electrons-cm^{-2}-sec^{-1} at $L = 2.6$ where the characteristic energy is 8 MeV. The predicted proton flux model has a peak flux of 3.5×10^{10} protons-cm^{-2}-sec^{-1} at $L = 1.2$ where the characteristic energy is 600 MeV. The electrons trapped close to the planet are affected by another loss mechanism in addition to the synchrotron radiation loss. The nature of the additional loss cannot be determined using the available radio measurements. Several diffusion mechanisms were also studied, but none could be identified as causing the predicted diffusion. (Diss. Abstr. Int., B)

19338 NEUTRON-ACTIVATION ANALYSIS OF LUNAR SOIL BROUGHT BACK FROM MARE FECUNDITATIS BY LUNA-16. Surkov, Yu. A.; Kirnozov, F. F.; Ivanov, I. N.; Kolesov, G. M.; Ryvkin, B. N.; Shpanov, A. P. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 860-863(1972).

Translated from Kosm. Issled.; 10: No. 6, 943-947(1972).

The elemental composition of samples of lunar regolith brought back from Mare Fecunditatis by Luna-16 was determined by a radioactivation method using generator and reactor neutrons, and also by gamma spectrometry with scintillation and Ge(Li) detectors. (auth)

19339 TITAN REVISITED. Lewis, J. S.; Prinn, R. G. (Massachusetts Inst. of Tech., Cambridge). Comments Astrophys. Space Phys.; 5: No. 1, 1-7(Jan 1973).

It is stated that in the course of recent observations of Titan, Saturn's largest satellite, hydrogen has been detected in surprisingly large amounts, (about 5 km amagat) and the methane abundance has been redetermined to be 6.2 km amagat. Infrared emission measurements from wavelengths, $\lambda = 8$ to 20 μm, reveal a pronounced greenhouse effect, with a surface temperature of at least 145°K. Recent interpretations of the observations are discussed: one proposal was that the greenhouse effect is due to an extremely massive hydrogen-rich atmosphere (~100 km amagat of hydrogen): another, that the observed, much smaller, amount of hydrogen could have its 17-μm rotational band strongly enhanced by addition of ~50 km amagat of nitrogen. A model is now proposed for Titan, arising from consideration of the observational data, the thermodynamics, photochemistry and optical properties of a methane-rich atmosphere, and simple models for the origins and volatile content of the satellites of the outer planets. It is concluded that the present study has emphasized the possibility of a CH_4-rich atmosphere on Titan and that this should be kept in mind as a viable alternative to a N_2-rich model. (UK)

19340 REMOTE SOUNDING FROM ARTIFICIAL SATELLITES AND SPACE PROBES OF THE ATMOSPHERES OF THE EARTH AND THE PLANETS. Houghton, J. T. (Oxford Univ.); Taylor, F. W. Rep. Progr. Phys.; 33: No. 7, 827-919(1973).

Observation of radiation reflected, scattered, or emitted in various regions of the electromagnetic spectrum can yield information about the structure of a planetary atmosphere. Instrumentation for the measurement of temperature, density, and composition and for cloud imaging is described, methods of information retrieval from radiometric observations are discussed, and some of the results for the atmospheres of Earth, Mars, and Venus are presented. Further developments are considered particularly in the light of the information of the possible mechanisms for climatic change. (auth)

19341 UPPER LIMIT TO THE 11.4 FLUX OF SATURN USING VLBI. Shawhan, S. D.; Clark, T. A.; Cronyn, W. M.; Basart, J. P. (Ionics, Inc., Cambridge, MA). Nature (London) Phys. Sci.; 243: No. 126, 65-66(28 May 1973).

It is stated that searches continue for nonthermal continuum and noise storm radio emissions from Saturn that might be analogous to the decimetric and decametric emissions from Jupiter. A series of interferometric observations of Saturn is here reported using large phased dipole arrays at 11.4 m (26.3 MHz) wavelength. The results were interpreted as negative for both decametric continuum and noise storm emission from source regions much less than the planetary disk size, and led to an upper limit value of ~14 fu from a source less than 1 arc s in diameter, located in a region ±40 min in RA and 3.5° in declination about Saturn's optical position. The observations were made in August 1971 using the Mark I very long baseline interferometry (VLBI) tape recording terminals of the National Radio Astronomy Observatory. Details are given of the technique adopted and of the data analysis system used. (UK)

19342 STRUCTURE OF JUPITER AND SATURN. Hubbard, W. B. (Univ. of Arizona, Tucson); Smoluchowski, R. Space Sci. Rev.; 14: No. 15, 599-662(Jun 1973).

Understanding of the planetary interiors depends upon a knowledge of the equations of state and of the transport properties of matter at high pressures and temperatures. The present status of this knowledge in relation to hydrogen and helium is discussed in detail including electrical and thermal conductivity, viscosity, diffusivity, etc. On this basis the various possible models of the internal structure of Jupiter and of Saturn are presented and their agreement with observational constraints such as the multipole gravitational coefficients analyzed. Relevance of planetary magnetic fields, basic atmospheric information, and the Great Red Spot of Jupiter to the models of the interiors are discussed. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 18123 and 19270.

19343 (AD-757358) DNA PROJECT 617 RADAR: AURORAL IONOSPHERIC MEASUREMENTS. Final Report, 15 November 1971-15 November 1972. Baron, M. J. (Stanford Research Inst., Menlo Park, Calif.). Dec 1972. Contract DNA001-72-C-0076. 313p. NTIS.

The DNA Project 617 incoherent-scatter radar has been operating at its Chatanika, Alaska location for eighteen months. This report describes the research studies pursued by SRI in 1972, including the following: Investigation of high-latitude ionospheric plasma-transport phenomena; Studies of ionospheric plasma interaction with the neutral atmosphere; Studies of auroral ionization; Correlative studies with the Homer Project 609 auroral clutter radar; Radar measurements in support of rocket-borne experiments (including ICE CAP '72); Diurnal/seasonal behavior of the auroral ionosphere; Measurements of the ionospheric effects of the August 1972 solar storm; Effects of the July 10, 1972 total solar eclipse; Investigation of ionospheric conditions responsible for spread-F. (NTIS)

19344 (AD-757507) PHENOMENOLOGICAL MODEL OF GLOBAL IONOSPHERIC ELECTRON DENSITY IN THE E, F1, AND F2 REGIONS. Report for May-December 1972. Ching, B. K.; Chiu, Y. T. (Aerospace Corp., El Segundo, Calif.). 1 Mar 1973. Contract F04701-72-C-0073. 51p. (SAMSO-TR-73-91). NTIS.

A global phenomenological model of the large scale variations of ionospheric electron density with the annual, diurnal, and solar activity cycles was constructed from monthly-averaged hourly ionospheric sounding data from some 50 stations spanning the years 1957-1970 as provided by World Data Center (A), Boulder, Colorado. The model, summarizing the data in simple empirical formulae and thus requiring little computer storage, is specifically for global thermospheric and ionospheric dynamical calculations such as ion drag, Joule heating, and atmospheric dynamo effects which require electron or ion densities as essential inputs. Extensive comparison of the model with data and with other models is discussed. (auth) (NTIS)

19345 (AD-757637) RESEARCH OF AEROPHYSICS INSTITUTE FOR STRATEGIC TECHNOLOGY. Semi-Annual Technical Summary for Period Ending 31 August 1972. Bloom, M. H. (Polytechnic Inst. of Brooklyn, N. Y.). Mar 1972. Contract DAHCO4-69-C-0077. 24p. (PIBAL-72-B; AROD-8677-33-P). NTIS.

The report contains a description of the technical problem areas and accomplishments achieved during the reporting period. In addition, a complete list of publications, presentations, lectures, etc. is included and the personnel associated with the program are listed. The research projects are in the general subject areas of fluid and plasma dynamics. (NTIS)

19346 (AD-758064) LABORATORY SIMULATION OF ARTIFICIAL PLASMA CLOUDS IN THE IONOSPHERE. Technical Report. Morse, D. L.; Destler, W. W. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). Mar 1973. Contract N00014-67-A-0077-0002. 40p. (LPS-114). NTIS.

The results of an experiment to model the behavior of artificial plasma clounds in the ionosphere are presented. The formation of field-aligned structure or striations is frequently observed. The appearance of this structure and its subsequent motion are found to be in substantial agreement with theory. In particular, the ratio of the integrated Pedersen conductivity of the cloud to that of the background through which it moves is found to be an important factor determining the growth rate of the striations. (auth) (NTIS)

19347 (AD-758201) GEOPHYSICS AND SPACE DATA BULLETIN. Volume 9, Number 4. 4th Quarter Report, October-December 1972. Carrigan, A. L. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Mar 1973. 338p. (AFCRL-73-127; AFCRL-SR-154). NTIS.

The Bulletin is a quarterly publication that contains AFCRL contract and inhouse data reported from sites throughout the world. The following types of data are contained within each issue: magnetometer, cosmic ray, elf noise, riometer, solar optical and radio emission, and ionosponde. This issue covers such data for October, November, and December 1972. (auth) (NTIS)

19348 (AD-758775) ELECTRICAL CONDUCTIVITY OF THE MESOSPHERE (40 km to 100 km) FROM ELF SPECTRA. Final Report, 16 November 1969-15 November 1972. Tran, A.; Polk, C. (Rhode Island Univ., Kingston. Dept. of Electrical Engineering). 15 Feb 1973. Contract F19628-70-C-0090. 43p. (AFCRL-TR-73-168). NTIS.

The Schumann resonance frequencies of the Earth-Ionosphere cavity at approximately 8, 14, and 20 Hz provide a method for obtaining a world average of the (zero-magnetic field) electrical conductivity of the "ionosphere" down to 40 km altitude. If the cavity Q or wave attenuation can be accurately measured, the average electrical conductivity below 40 km can also be determined. Numerical models are analyzed to show the effect of conductivity changes at various altitude ranges upon the resonance frequencies. Several conductivity profiles for periods corresponding to different levels of solar activity are derived from experimentally determined Schumann resonance frequencies. (auth) (NTIS)

19349 (AD-758779) IONOSPHERIC HEATING ANALYSIS. Interim Technical Report, 1 June-30 November 1972. Gordon, W. E.; Carlson, H. C. (Rice Univ., Houston, Tex.). Dec 1972. Contract F30602-72-C-0278. 34p. (RADC-TR-73-82). NTIS.

The hf excited plasma line is observed to fluctuate by an order of magnitude about its mean value, the downshifted decay line being about $\frac{4}{3}$ the amplitude of the upshifted line. The results obtained by Kantor on the role of the Airy function in explaining one form of the fluctuations has been confirmed. Red line enhancement and suppression in the airglow have been observed. In addition to enhancements of the plasma at and near the plasma line frequency and at the ion line frequency, enhancements have been observed at the electron gyro-frequency and at twice this frequency. (NTIS)

19350 (AD-758855) IONOSPHERIC EFFECTS DURING THE PARTIAL SOLAR ECLIPSE OF JULY 10, 1972. Technical Report. Soicher, H.; Gorman, F. J. Jr. (Army Electronics Command, Fort Monmouth, N. J.). Mar 1973. 12p. (ECOM-4097). NTIS.

Polarization measurements at Fort Monmouth, N. J., using ATS-3 emitted signals and bottomside ionospheric sounding measurements at the subionospheric point were performed during the partial solar eclipse of July 10, 1972. A decrease in the total electron content and the plasma temperature ensued with corresponding diffusive particle fluxes into heights of maximum ionization. The diffusion rate to the height of maximum ionization was comparable to the recombination rate at that altitude. (auth) (NTIS)

19351 EARTH'S SHADOW IN THE LITHIUM 6707 A LINE. Lloyd, K. H. (Weapons Research Establishment, Salisbury, Eng.). J. Atmos. Terrest. Phys.; 35: No. 8, 1529-1537(Aug 1973).

Observations on the Earth's shadow, rising on a trail of lithium released from a rocket, have shown that its sharp definition was produced by cirrus cloud. The shadow profile was time-invariant, if the Sun's rays are defined in terms of their grazing height. The conclusions drawn from the observations on the shadow have implications for the crepuscular (twilight) ray method of determining the profile of the alkali elements in the upper atmosphere. In particular, it appears that least ambiguous results are obtained when cloud is present at the grazing point. (auth)

19352 PROPAGATION STUDY OF VLF WAVES IN THE EARTH IONOSPHERE WAVE-GUIDE USING RECEIVERS ABOARD A BALLOON AND ON THE GROUND. Thiel, J.; Cory, H.; Vigneron, J.; Bercy, C. (Centre National de la Recherche Scientifique, Saint-Maur-des, France). J. Atmos. Terrest. Phys.; 35: No. 8, 1539-1559(Aug 1973).

In order to investigate the Earth-ionosphere waveguide, two balloons were launched on November 12, 1969 and September 17, 1970, in southern France and attained heights of 36 and 37.2 km, respectively. The E.M. field transmitted by the 16.8 kHz antenna of Sainte Assise near Paris (at a distance of 580 km from the launching site) was received simultaneously at the balloons, by three magnetic loops and three electric antennas, and at the ground. The observations form the basis of a new contribution to the study of vlf propagation and give information about the influence of both the ground and the ionosphere. However it was not possible to determine a unique electron density profile of the lower ionosphere from the experimental data. (auth)

19353 EFFECTS OF AN ELECTRIC FIELD ON THE DYNAMICAL BEHAVIOR OF THE IONOSPHERE AND ITS APPLICATION TO THE STORM TIME DISTURBANCE OF THE F LAYER. Tanaka, T.; Hirao, K. (Tokyo Univ.). J. Atmos. Terrest. Phys.; 35: No. 8, 1443-1452(Aug 1973).

The effects of an eastward electric field on the ionosphere are examined. Equations of motions for ions and neutral gas coupled with ion continuity equations and heat conduction equations are solved as a time dependent problem. Then the results of the calculation are compared with observed results obtained by Evans (J. Atmos. Terr. Phys.; 32: 1629 (1970)) during a magnetic storm. It is proposed that the anomalous evening increase of N_mF2 (the maximum electron concentration of the F layer), which occurs during a severe geomagnetic storm, can be interpreted in terms of the effects of an eastward electric field. By arguing detailed structures of the anomalous evening increase of N_mF2 it is shown that an eastward electric field of the order 5 to 8 mV/m can be responsible for this phenomenon. (auth)

19354 ESTIMATE OF THE EQUATORIAL ELECTROJET STRENGTH. Kane, R. P. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys.; 35: No. 8, 1565-1567(Aug 1973).

It is stated that in studying the characteristics of the equatorial electrojet strength from the observations of H variations at ground, it is necessary to correct for magnetospheric changes which may be universal time dependent as well as local time dependent. It is considered that these corrections are necessary even on weakly disturbed days. Ionospheric effects in E and F regions, f_0F2, and the geomagnetic latitude θ for any station are taken into account, as well as magnetospheric effects and magnetic field disturbances. A measure is derived which seems appropriate for both quiet and disturbed periods. (UK)

19355 RESPONSE OF THE IONOSPHERIC ELECTRON CONTENT OF FLUCTUATIONS IN SOLAR ACTIVITY. Da Rosa, A. V.; Waldman, H.; Bendito, J. (Stanford Univ., CA). J. Atmos. Terrest. Phys.; 35: No. 8, 1429-1442(Aug 1973).

An investigation is made of the influence of the solar activity on the ionospheric electron content. Both the long and short term effects are studied. It is shown that a linear relationship exists between the value of the daily mean electron content and the solar radio flux at 2.8 GHz. The coefficients of the linear regression between these two variables are dependent on the day of the year, showing marked annual variation. The sensitivity of the ionosphere seems to be the same for both short period and long term fluctuations of solar radio flux. A delay of between 1 and 3 days is found between the fluctuations in microwave flux and corresponding changes in the ionosphere. Delays observed in Hawaii were longer than those at Stanford. Using the linear relationship between solar radio noise and the mean electron content, it is possible to prognosticate with reasonable accuracy the mean daily value of the electron content. (auth)

19356 VLF PROPAGATION AT AURORAL LATITUDES. Westerlund, S. (Geophysical Observatory, Kiruna, Sweden); Reder, F. H. J. Atmos. Terrest. Phys.; 35: No. 8, 1453-1474 (Aug 1973).

Vlf (10 to 30 kHz) radio wave propagation at auroral latitudes (60° to 75°) is frequently disturbed by precipitated electrons. Ionospheric activity as revealed by optical aurora, magnetic disturbances, or riometer absorption usually shows rather good correlation with vlf anomalies, especially during night. Large vlf disturbances which occur during both day and night, and predominantly on signals arriving at Kiruna from the south, often show poor correlation with other indications of ionospheric disturbances. They are believed to be caused by high-energy electrons (>200 keV) precipitated mainly in a narrow zone below L = 6. These events are probably closely related to Bailey's (Rev. Geophys.; 6: 289 (1968)) relativistic electron precipitations although vlf signals provide a more sensitive indicator than forward scatter transmissions. Sudden commencements (SC's) of geomagnetic storms are connected with high latitude electron precipitation. The related vlf anomalies are small and coincide with the SC or are delayed up to a few minutes. (auth)

19357 WIND, ELECTRIC FIELD, AND COMPOSITION PERTURBATIONS OF THE MID-LATITUDE F-REGION DURING MAGNETIC STORMS. Jones, K. L. (Univ. of Queensland, St. Lucia, Australia). J. Atmos. Terrest. Phys.; 35: No. 8, 1515-1527(Aug 1973).

A theoretical investigation of possible storm-time neutral air wind, electric field, and composition perturbations of the F-region has been undertaken using a mathematical model of the atmosphere in the altitude range 120 to 800 km. The results confirm and extend previous calculations using a simple servo-model of the F2 peak. Estimates of the likely variation of such parameters as total electron content, peak electron concentration, and height of the F2 peak of the perturbed ionosphere are provided for comparison with experimental data. (auth)

19358 SEASONAL ANOMALY IN IONOSPHERIC RADIO WAVE ABSORPTION. Jones, E. S. O.; Rees, R. L. D. (Bedford Coll., London). Nature (London) Phys. Sci.; 243: No. 129, 112-113 (18 Jun 1973).

An examination was made of the seasonal lag of radio wave absorption at mid- and low-latitude stations for all available data for several stations up to December 1970. It was found that in mid latitudes the absorption was anomalously high during the four winter months. (UK)

19359 EFFECT OF SOLAR ACTIVITY ON TEMPERATURES IN THE EQUATORIAL MESOSPHERE. Ramakrishna, S.; Seshamani, R. (Indian Inst. of Science, Bangalore). J. Atmos. Terrest. Phys.; 35: No. 9, 1631-1641(Sep 1973).

A study of the response of neutral temperatures in the equatorial mesosphere to variations in solar activity has been carried out by investigating the correlation between the 10.7 cm solar radio flux and temperatures obtained from a series of 51 rocket soundings conducted over Thumba, India (8°N, 77°E) during the period December 1970–December 1971. A strong positive correlation between these two parameters has been obtained, indicating mesospheric heating effects caused by day-to-day variations in solar euv emission. The correlation analysis indicates that this response persists over several days and that the peak correlation between the temperatures and the $F_{10.7}$ index occurs with a time lag of less than 24 hr. (auth)

19360 ATMOSPHERIC TEMPERATURE MEASUREMENT USING BALLOONS AND ROCKETS. Morrissey, J. F. (Air Force Cambridge Research Labs., Bedford, MA). pp 2299-2311 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

The methods of measurement of atmospheric temperature using balloons and rockets are reviewed. Included is a general discussion of the nonroutine techniques and a detailed examination of the routine techniques. These routine techniques are immersion type sensors and are used from the surface to 70 km. The significant energy transfer processes are discussed with regard to the problems of repeatability and accuracy. Also discussed are the effects of variations in these energy transfer processes with altitude, geographical location and time. (auth)

19361 SPECTROSCOPIC MEASUREMENT OF UPPER ATMOSPHERIC TEMPERATURE. Shepherd, G. (York Univ., Toronto). pp 2313-2327 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

The remote sensing nature of auroral and airglow spectroscopy offers the capability of deducing upper atmospheric temperatures from observations made at ground level. Before rockets and satellites this was one of the very few methods available. Even now, advances in the techniques, coupled with natural advantages, continue to make the method important. The physics of rotational and Doppler temperatures, and their application to the atmosphere are described, along with the spectroscopic devices employed. The familiar grating spectrometer can be used for some of these measurements but for others, the more specialized Fabry-Perot spectrometer or Michelson interferometer is required. These devices are described in some detail. (auth)

19362 TEMPERATURE MEASUREMENTS IN THE THERMOSPHERE AND IONOSPHERE. Van Zandt, T. E. (National Oceanic and Atmospheric Administration, Boulder, CO). pp 2329-2336 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

The atmosphere in the region of the thermosphere and ionosphere is a partially ionized plasma, consisting of neutral atoms and molecules, ions, and electrons. The energy distributions of the neutral particles, ions, and electrons are very nearly maxwellian, but they can have different temperatures. The electron and ion temperatures can be measured by Langmuir probes and by incoherent scatter. Other methods are unreliable or seldom used. The neutral temperature can be measured by optical methods, by calculation from T_e and T_i, and from the scale height of a constituent in diffusive equilibrium. The various methods are inter-

compared. It is concluded that some types of Langmuir probes give erroneously high electron temperatures, but that the other methods of measuring the electron, ion, and neutral temperature agree within their estimated errors. (auth)

19363 PROTONOSPHERIC COLUMNAR ELECTRON CONTENT DETERMINATION. I. Analysis. Almeida, O. G. (Stanford Univ., CA). J. Atmos. Terrest. Phys.; 35: No. 9, 1657-1675 (Sep 1973).

A combination of phase-path length difference and Faraday rotation angle data obtained from geostationary satellite transmissions is used to determine the integration constant necessary to convert phase-path length difference information into absolute values of total slant columnar electron content. The total content thus determined, which is the sum of the ionospheric and protonospheric contents, is measured with uncertainties about one order of magnitude smaller than the value of the protonospheric content. It is thus, in principle, possible to determine the latter by subtracting from the measurement the so-called "Faraday content." This idea, proposed by several authors in the past, is critically examined in the present paper. It is impossible to totally eliminate the ionospheric contribution to the measurements; however, it is shown that the degree of elimination depends on the type of distribution of the longitudinal component of the geomagnetic field along the path of observation. Satisfactory minimization of the ionospheric contribution can be accomplished only under certain geometries of observation. For such geometries the difference between the total electron content and the "Faraday content" is interpreted as protonospheric content based on diffusive equilibrium models of the ionization distribution. It is shown that this difference reflects 90% of the electron content above 2300 km. For other geometries, information on the shape and height of the ionospheric layer is necessary to improve the minimization of ionospheric contamination. (auth)

19364 MEASUREMENTS OF MeV ELECTRONS DURING THE RECOVERY PHASE OF A POLAR MAGNETIC SUBSTORM. Boehm, J. Atomkernenergie; 20: No. 3, 211-212(1972). (In German).

During an auroral event high-energy electrons with energies between 2.5 and 3.5 MeV were measured by a rocketborne experiment. The origin of these particles is discussed. (GE)

19365 SATELLITE AND GROUND-BASED OBSERVATIONS DURING THE ONSET PHASE OF THE 2 NOVEMBER 1969 PCA EVENT. Larsen, T. R. (Forsvarets Forskningsinstitutt, Kjeller, Norway); Lindalen, H. R. J. Atmos. Terrest. Phys.; 35: No. 9, 1643-1655(Sep 1973).

Very low frequency (vlf) observations from transpolar and high northern latitude paths during the initial phase of the polar cap absorption (PCA) event that started on November 2, 1969 are described. Proton data from the polar orbiting satellite ESRO IA are presented for three consecutive crossings of the northern polar cap, one before and two during the early stage of the event. These particle data and the onset times of ionospheric disturbances, as deduced from the vlf records, are discussed in relation to other satellite observations in interplanetary space, magnetotail and at synchronous orbit of energetic particles emitted from the PCA flare. (auth)

19366 DUCTED PROPAGATION OF LOW-LATITUDE WHISTLERS DEDUCED FROM SIMULTANEOUS OBSERVATIONS AT MULTISTATIONS. Hayakawa, M.; Ohtsu, J. J. Atmos. Terrest. Phys.; 35: No. 9, 1685-1697(Sep 1973).

The ducted propagation of low-latitude whistlers is studied by making use of simultaneous observations at several stations in Japan, i.e., Kagoshima (geomag. lat. 20°N), Sakushima (24°N), and Moshiri (34°N). The analyses are based on 5 days of highest whistler activity in February 1970, and the observed characteristics are given separately for sunset and nighttime whistlers. The observed results are found not to be explained in terms of nonducted propagation by using a ray-tracing technique, and the observations are satisfactorily explained by ducted propagation. Also the path latitudes of sunset and nighttime whistlers are roughly estimated. (auth)

19367 COSMIC RADIO NOISE ABSORPTION AND HYDROGEN EMISSION IN THE AURORAL SUBSTORM. Kilfoyle, B. P.; Jacka, F. (Univ. of Adelaide). Aust. J. Phys.; 26: No. 2, 225-228(Apr 1973).

From a study of records from Mawson, Kiruna, and Murmansk it is shown that slowly varying ionospheric absorption (SVIA) and Hβ emission are characteristic of the region behind the midnight poleward bulge of the auroral substorm, in accord with the model of Akasofu (1968). (auth)

19368 PROPAGATION OF IONOSPHERIC WHISTLERS AT LOW LATITUDE. Hayakawa, M.; Ohtsu, J.; Iwai, A. (Nagoya Univ., Japan). J. Atmos. Terrest. Phys.; 35: No. 9, 1677-1684 (Sep 1973).

The K-9M-26 rocket was launched from Kagoshima Space Center in Japan (geomag. lat. 20°N) to study the propagation characteristics of ionospheric or short fractional-hop whistlers coming from the local Earth-ionosphere waveguide. Their dispersion and amplitude characteristics are investigated in detail, and they are checked against the propagation theory. An analysis of their dispersions shows that the quasi-longitudinal (QL) approximation is pertinent above the E region even at such low latitudes as 20°. Then it is found from the study of wave field intensities that the observed ionospheric whistlers are identified as having propagated up to the rocket after propagation in the Earth-ionosphere waveguide over considerable distances. (auth)

19369 PROTONS AND ALPHA PARTICLES DURING POLAR-CAP ABSORPTION EVENTS. Witte, M.; Hempe, H. Atomkernenergie; 20: No. 3, 191(1973). (In German).

During two solar proton events (Feb. 25, 1969 and Jan. 24, 1971) the proton-to-alpha ratio was investigated by means of two rocket flights. The results were used for calculations concerning the expansion models of particles in interplanetary space and for calculations on the reconstruction of the injection spectra. (GE)

19370 PHENOMENOLOGICAL MODEL OF GLOBAL IONOSPHERIC ELECTRON DENSITY IN THE E-, F1-, AND F2-REGIONS. Ching, B. K.; Chiu, Y. T. (Aerospace Corp., El Segundo, CA). J. Atmos. Terrest. Phys.; 35: No. 9, 1615-1630(Sep 1973).

A global phenomenological model of the large scale variations of ionospheric electron density with the annual, diurnal, and solar activity cycles has been constructed from monthly-averaged hourly ionospheric sounding data from some 50 stations spanning the years 1957-1970 as provided by World Data Center (A), Boulder, Colorado. The model, summarizing the data in simple empirical formulae and thus requiring little computer storage, is specifically designed for global thermospheric and ionospheric dynamical calculations such as ion drag, Joule heating, and atmospheric dynamo effects which require electron or ion densities as essential inputs. Extensive comparison of the model with data and with other models is discussed. (auth)

19371 OBSERVATION OF IONOSPHERIC STORMS AT LOW LATITUDES AND THEIR CORRELATION WITH MAGNETIC FIELD CHANGES NEAR THE MAGNETIC EQUATOR. Walker, G. O. (Hong Kong Univ.). J. Atmos. Terrest. Phys.; 35: No. 9, 1573-1582(Sep 1973).

Eight major magnetic storm periods occurring under sunspot maximum conditions (1968-1969) have been investigated using total electron content N_T, maximum electron density N_m, and magnetic field data taken at low latitudes. Near Hong Kong (lat. 22.2°N, dip 30°) the main phase onset (MPO) of a storm occurring during the daytime was sometimes preceded by a slight increase and often followed by a sharp decrease in N_m and N_T, changes in N_m being usually the most significant. The earlier the occurrence of the MPO after local midnight the more pronounced was an observed irregular build-up of ionization after sunrise. Abrupt changes of the horizontal component of the geomagnetic field near the magnetic equator were often followed 2-3 hr later by similar sign changes in N_m near Hong Kong and opposite sign changes in N_m at Manila (10° lat. nearer the Equator). These results imply that during storms there are current variations induced in the electrojet region and the corresponding eastward electric field which uplifts ionization at the magnetic equator also changes. It appears that during the main phases of the storms there were often reductions in the intensity of this eastward electric field (even reversals on some occasions) and the development of the equatorial anomaly was consequently retarded. During the northern summer a large day-to-day variability has been observed, even on magnetically quiet days, of the effect of the electrojet at the magnetic equator and of the development of the equatorial anomaly. Storms occurring during this summer period have not been included. (auth)

19372 CHARACTERISTICS OF THE DYNAMIC SPECTRUM OF π2 TYPE PULSATIONS. Antonova, E. E.; Tverskoy, B. A. Feygin, F. Z. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 978-981(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1127-1129(1972).

The dynamic spectra of Pi2 type pulsations are examined schematically. The effects of generation and damping of pulsations are neglected and the evolution of a wave pocket generated at instant t = 0 and propagating without damping along the line of force is considered. (WDM)

19373 EVALUATION OF THE ACCURACY OF LONGITUDINAL INTERPOLATION OF f_0F_2 BASED ON SHIP OBSERVATIONS. Vasil'eva, T. N.; Vasil'yev, K. N. (Inst. of Terrestrial Magnetism,

Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 966-968(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1115-1117(1972).

The procedure of preparation of MUF forecasts is based on observations at the global network of ionospheric observatories. In areas poorly covered by ionospheric data (for example, oceans), it is necessary to resort to interpolation. Of the regular layers of the ionosphere, the F2 layer has the most complex geographical distribution, and therefore the interpolation of f_0F2 in the unexplored areas is often difficult. At the present time, the longitude effect is used in interpolating f_0F_2. It is assumed that observatories located along the same geomagnetic latitude have similar f_0F_2 values. The accuracy of the longitudinal interpolation of f_0F2 is determined from data of ionospheric observations on the R/V Zarya .d Akademik Kurchatov. (WDM)

19374 VELOCITY OF WEAK INHOMOGENEITIES IN THE IONOSPHERIC PLASMA. Zhmur, L. E. (Gorky State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 968-970 (1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1118-1119(1972).

The differences between the characteristic velocity and the group velocity are examined for a homogeneous plasma, neglecting the diffusion and collisions between charged particles. (WDM)

19375 SPECTRUM OF ATMOSPHERIC γ-RAYS WITH ENERGIES FROM 0.3 TO 2.6 MeV. Lenin, A. S.; Romanov, A. M.; Chuykin, Y. I. (Ioffe Inst. of Physics and Tech., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 860-865(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 989-995.

The spectra of energy losses of γ quanta in a scintillation spectrometer of the "Phoswich" type at different depths in the atmosphere are presented. They were obtained in 1970 on balloons at a point with $\Phi = 47°$. A method of determining γ-ray spectra from the measured spectrum of energy losses is described. The spectra of γ rays with E = 0.3 to 2.6 MeV are presented for depths of 270 to 7 $g \cdot cm^{-2}$. (auth)

19376 ESTIMATION OF THE SEASONAL VARIATION OF THE GAS COMPOSITION OF THE HEIGHT OF THE F_1-LAYER FROM DATA ON THE CONDITIONS OF ITS DEVELOPMENT. Shchepkin, L. A.; Shuyskaya, Z. I.; Koshelev, V. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 870-872(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1000-1003(1972).

Seasonal variations in the conditions of F1-layer development were obtained from vertical sounding data at Irkutsk during a solar activity minimum (1965). Experimental and theoretical data were used to obtain the seasonal variations in the gas composition of the atmosphere at F1-layer levels. It was demonstrated that the $[O]/[N_2]$ ratio is minimal in summer and maximal in March and October. (auth)

19377 ION COMPOSITION AND PHOTOCHEMISTRY OF THE E REGION. Danilov, A. D. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 873-877(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1009-1012(1972).

The results of rocket investigations of the ion composition of the E region are analyzed. Several conclusions are derived regarding the nature of the density variations of the main ions with the time of day and solar activity. (auth)

19378 SPACE-TIME DISTRIBUTION OF E_s FORMATIONS ASSOCIATED WITH VISIBLE AURORAL FORMS. Besprozvannaya, A. S.; Shchuka, T. I. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 878-881(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1009-1012.

The results of an analysis of the geographic distribution of the probability of appearance of E_s of the flat and auroral types are reported. From an analysis of data for 1958 it follows that the latitude dependence of P_{E_s} is double-peaked. A similarity is noted between the P_{E_s} patterns found and the splitting of the zone of visible auroras and magnetic activity. (auth)

19379 PROBLEMS CONCERNING THE METHOD OF DETERMINING THE PARAMETERS OF SCATTERING INHOMOGENEITIES. Gusev, V. D.; Nguen Bik Lan (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 882-886(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1013-1019(1972).

The possibility of using the correlation method to determine the average shape and movement of scattering ionospheric inhomogeneities is investigated on the basis of the phase correlation function obtained for a vertically incident scatter wave at the exit from a linear ionospheric layer. It is demonstrated that the observed deviations from the correlation method in its standard form take place in an inhomogeneous ionosphere with allowance for the vertical component of drift velocity. (auth)

19380 VARIATIONS IN THE TEMPERATURE OF THE THERMOSPHERE IN THE COURSE OF THE DAY AND WITH SOLAR ACTIVITY. Izakov, M. N.; Yashchenko, I. A. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 902-905(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1037-1041(1972).

Experimental data on the temperature of the upper thermosphere, obtained by different methods, are summarized. It is demonstrated that the position of the maximum of daily temperature variations at a given latitude is very variable, although it occurs most frequently at 15– 16h LT. The amplitude of daily temperature variations is practically independent of solar activity and probably experiences seasonal-latitude variations. The ratio of temperatures in the daytime global maximum and the nighttime global minimum varies within 1.2 and 1.7. The ratio of temperatures at the maximum and minimum of daily variations lies within 1.2 and 1.5 at a given latitude. (auth)

19381 PRODUCTION OF VIBRATIONALLY EXCITED O_2 AND NONTHERMAL INFRARED EMISSION IN THE UPPER ATMOSPHERE. Komkova, T. G.; Shved, G. M. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 906-908(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1042-1045(1972).

The main processes of production and decay of vibrationally excited molecular oxygen O_2 in the layer from 50 to 100 km during the daytime and at night are investigated. The maximum possible rate of production of vibrational quanta during the formation of O_2 by chemical reactions and by solar radiation absorption is estimated. (auth)

19382 CHARACTERISTICS OF HYDROMAGNETIC WAVE PROPAGATION IN A SLOWLY VARYING MAGNETIC FIELD (IN THE APPROXIMATION OF GEOMETRIC OPTICS). Antonova, E. E.; Tverskoy, Ba. A.; Feygin, F. Z. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 16, 931-937 (1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1074-1081(1972).

The propagation of hydromagnetic waves along a magnetic field that varies slowly in space and time in a plasma the density of which is a slowly varying function of the coordinates and time is investigated. It is demonstrated that in a nonstationary medium the wave frequency and amplitude must change with time even in the absence of any wave attentuation and buildup. This results in a change with time of the frequency spectrum of geomagnetic micropulsations. Known changes in the frequency spectra of type Pc1 micropulsations are examined. It is shown that the slowly changing carrier frequency of pearls with time can be associated with a substorm in the magnetosphere. (auth)

Magnetospheric Phenomena

19383 (AD–757085) STIMULATED AMPLIFICATION OF VLF AND ULF WAVES IN THE MAGNETOSPHERE BY LOCALIZED INJECTIONS OF PLASMA CLOUDS AND PARTICLE BEAMS. Final Report. Liemohn, H. B.; Parks, G. K. (Washington Univ., Seattle). Dec 1972. Contract N00014-67-0103-0027. 135p. NTIS.

The cyclotron resonance interaction between ulf–vlf waves and trapped particles may be strongly enhanced in the magnetosphere by the injection of either cold plasma or energetic particle beams. A variety of natural conditions and injections are investigated numerically using the linear theory. Both satellite and rocket injection of cold plasma provide significant enhancement of amplification. Conventional hot electron beams may also amplify narrow frequency bands, if the beam geometry can be effectively altered at injection. Heavy ion beams appear to offer attractive propagation conditions as well as stimulate amplification. (auth) (NTIS)

19384 (AD-757866) COUPLED HYDROMAGNETIC MODES: INITIAL VALUE PROBLEMS. Radoski, H. R. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 29 Dec 1972. 15p. (AFCRL-72-747; AFCRL-PSRP-524). NTIS.

Before micropulsations can be utilized as a diagnostic tool, the critical theoretical problem of coupled hydromagnetic modes must be appreciated. Several alternative analyses of the steady state solutions of coupled modes have been proposed. In determining which, of any, steady state solution is of physical significance, the manner in which the hydromagnetic system evolves from an initial disturbance would be decisive. The basic initial value problems are those of field line excitation and relaxation. At present, these problems are investigated best by using a mechanical analogue of the resonant interaction between hydromag-

netic modes. The transient response as well as the transmission and reflection coefficients have been calculated for the excitation problem. Analysis of the relaxation problem indicates that the characteristic frequency of the radiated signal need not be identical to the field line frequency. For the case treated, the frequency is always less and the waveform can appear as a single pulse. Results suggest that damped oscillations should be the characteristic signature of micropulsations propagated to low latitudes. (auth) (NTIS)

19385 (AD-757874) AEROSPACE CORPORATION SPACE SCIENCE PROGRAM REPORT TO COSPAR, CY 72. Paulikas, G. A. (Aerospace Corp., El Segundo, Calif.). 30 Jan 1973. Contract F04701-72-C-0073. 19p. (SAMSO-TR-73-102). NTIS.

The Laboratories of The Aerospace Corporation are carrying out a research program in the space sciences consisting of both satellite based and ground based observations. This report summarizes the results obtained in CY 1972. Research efforts during the past year concentrated on the physics of the upper atmosphere, solar-terrestrial interactions, magnetospheric physics, and solar physics. (auth) (NTIS)

19386 (AD-758101) LOW-ENERGY PARTICLE EXPERIMENT. Annual Technical Report, 1 April 1972 – 31 March 1973. Shelley, E. G. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab). 23 Mar 1973. Contract N00014-72-C-0234. 14p. (LMSC-D-315650). NTIS.

The program is directed toward an improved understanding of the sources and the energization, transport, and loss processes associated with the low-energy (keV) plasmas in the magnetosphere, particularly as they relate to ionospheric perturbations and to ionospheric–magnetospheric coupling. A low-energy particle experiment is planned for flight on a polar-orbiting Air Force Satellite, and the principal efforts to date have been on modifications to the initial experiment to take into account new data on the magnetospheric plasma composition and on defining the experiment interfaces with the spacecraft in conjunction with the spacecraft Integrating Contractor and the Air Force. (auth) (NTIS)

19387 (AD-758196) NUMERICAL MODEL OF THE EQUATORIAL ELECTROJET. Richmond, A. D. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 16 Nov 1972. 69p. (AFCRL-72-668; AFCRL-ERP-421). NTIS.

A computer program which calculates electron and ion densities, ionospheric conductivities, electric fields and currents, and magnetic variations in regions near the magnetic equator is described in detail. It is also explained how this numerical model can be used to deduce F-region vertical plasma drifts in the equatorial ionosphere from observed magnetic variations at ground level. (auth) (NTIS)

19388 (N-73-18397) TIME VARIATIONS OF MAGNETOSPHERIC INTENSITIES OF OUTER ZONE PROTONS, ALPHA PARTICLES, AND IONS ($Z \geq 2$). Randall, B. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan 1973. Contract NAS1-8141. 73p. (NASA-CR-130860). NTIS.

Thesis.

A comprehensive study of the temporal behavior of trapped protons, alpha particles, and ions ($Z > 2$) in outer zone of the magnetosphere was made. These observations were made by the Injun V satellite during the first 21 months of operation, August 1968 to May 1970. Rapid increases in the observed number of particles followed by slower exponential decay characterize the data. Comparisons are made with the temporal behavior of interplanetary particles of the same energy observed by Explorer 35. Increases in the trapped fluxes generally correspond to enhanced interplanetary activity. The energy spectra of protons and alpha particles at $L = 3$ have similar shapes when compared on an energy per charge basis while the respective polar cap spectra have similar shape on an energy per nucleon basis. Apparent inward trans-L motion of energetic protons is observed. These particles are diffused inward by a process involving fluctuating electric fields. The loss of trapped low-altitude protons, alpha particles, and ions ($Z > 2$) is controlled by coulombic energy loss in the atmosphere. (STAR) (auth)

19389 (N-73-18423) RELATIONSHIP BETWEEN THE GROWTH AND EXPANSION PHASES OF SUBSTORMS AND MAGNETOSPHERIC CONVECTION. Mozer, F. S. (California Univ., Berkeley. Space Sciences Lab.). 5 Jul 1972. Contract NAS5-10362. 15p. (GA-111259; NSF-GA-17328; NASA-CR-130499). NTIS.

It is suggested that the definition of the growth and expansion phases of substorms should rest on magnetospheric convection theories and data because of the ambiguities in interpretation of ground magnetometer records from which these concepts arose originally. Data such as that discussed in the report offers strong evidence for the validity and usefulness of the concepts of the growth and expansion phases. (STAR) (auth)

19390 MEASUREMENTS OF ELECTRIC FIELDS IN THE IONOSPHERE. Klos, Z. (Inst. of Geophysics, Warsaw). Postepy Astron.; 21: No. 2, 127-139(1973). (In Polish).

This paper deals with the methods of measurement of the steady electric fields in the terrestrial upper atmosphere. First, different methods of the measurement are reviewed then their applicability to practical purposes are considered. Measurements with a dual Langmuir probe are discussed in greater detail. (auth)

19391 INITIATION OF A DISCHARGE IN CROSSED FIELDS: APPLICATION TO THE IONOSPHERE IN THE AURORAL ZONE. Akoum, F.; Quemada, D. (Univ., Paris). Compt. Rend., Ser. A, B; 276: No. 15, 677-680(9 Apr 1973). (In French).

Comparisons between the coefficients of ionization of electrons and ions in the presence of the Earth's magnetic field and a horizontal electric field demonstrated that atmospheric ions are predominant in the creation of the ionospheric plasma while electron play only a minor role. The existence of a minimum critical field was shown necessary for the initiation of a discharge in the ionosphere. The variation of this field with altitude and latitude was also demonstrated. (FR)

19392 EFFECT OF THE INTERPLANETARY MAGNETIC FIELD ON MAGNETIC PERTURBATIONS IN HIGH LATITUDE REGIONS: ESTABLISHMENT OF THE EXISTENCE OF AN ASYMMETRY IN RELATION TO THE EARTH–SUN DIRECTION. Berthelier, A. (CNRS, Saint-Maur-des-Fosses, France). Compt. Rend., Ser. A; 276: No. 15, 681-684(9 Apr 1973). (In French).

It is shown that the component of the ecliptic of the interplanetary magnetic field responsible for the perturbations in the polar regions makes an angle between 10 and 40° west with the perpendicular Earth–Sun direction. This result can be interpreted by an asymmetry of the magnetosphere in relation to the Earth–Sun direction. (FR)

19393 DIURNAL VARIATIONS OF THE VERTICAL COMPONENT OF THE MAGNETIC FIELD IN HIGH LATITUDE REGIONS AS A FUNCTION OF THE EAST-WEST COMPONENT OF THE INTERPLANETARY MAGNETIC FIELD. Berthelier, A. (CNRS, Saint-Maur des-Fosses, France). Compt. Rend., Ser. A, B; 276: No. 16, 693-696(16 Apr 1973). (In French).

A phenomenon characteristic of the polar caps is an increase (or decrease) in Z associated with a West (East) Y component of the interplanetary magnetic field. When Y is zero, Z is almost constant. A high conductivity in the E region seems to be a prerequisite condition for the establishment of the Y effect and probably plays an important part in the phenomenon when the auroral activity is weak. (FR)

19394 PROTONS AND ALPHA-PARTICLES IN THE ENERGY RANGE $5 \leq E \leq 50$ MeV/N AT THE LOWER BORDER OF THE RADIATION BELT NEAR THE EQUATOR. Fischer, H.; Boehm, J.; Auschrat, V. W.; Schmieder, D. Atomkernenergie; 20: No. 3, 208-210(1972). (In German).

With the satellite DIAL protons and alpha particles ($5 \leq E \leq 50$ MeV/N) were measured near the equator at the lower boundary of the radiation belt. The purpose of these measurements was to study the particle populations in the radiation belt and their interactions with the upper atmosphere. (GE)

19395 RESULTS OF THE EXPERIMENT AZUR FOR MEASUREMENT OF LOW-ENERGY PROTONS. Moritz, J.; Lammers, E. Atomkernenergie; 20: No. 3, 205-207(1972). (In German).

In an experiment on board the satellite AZUR proton populations between 0.25 and 1.65 MeV have been investigated in the inner and outer radiation belts and over the polar caps. Beneath the radiation belt in equatorial latitudes a new and hitherto unknown population of low-energy protons was discovered. (GE)

19396 PULSED SYSTEM FOR GEOPHYSICAL MODELING. Il'yasov, E. L.; Lizunkova, I. S.; Yashukov, V. P. (Physical Technical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 984-986(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1133-1134(1972).

To elucidate the nature of certain geophysical phenomena, it is expedient to simulate them under laboratory conditions, which requires a correct reduction of the parameters describing these phenomena to the laboratory scale. Application of similarity transformations to space physics subjects shows that a sufficiently accurate model of the Earth ~10 cm in size should have a dipole magnetic field with an intensity of $\sim 10^6$ Gs at the equator. However, individual laboratory experiments on the Earth's radiation belts and on the interaction of the Earth's magnetic field with the solar wind can be performed only by using a dipole magnetic field with an intensity of $H \geq 10^3$ Gs at the equator of the model. The

construction of a terrella is proposed—a pulsed magnetic system that can be used in experiments of this type and has a magnetic moment $M \sim 10^4$ Gs cm^3. (WDM)

19397 GENERATION AND DECAY OF A NARROW BELT OF ENERGETIC ELECTRONS IN THE EARTH'S MAGNETOSPHERE. Gorchakov, E. V.; Ternovskaya, M. V.; Getselev, I. V. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 975-976(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1124(1972).

The Cherenkov detector installed on Kosmos 137 was able to record electrons with energies $E_e \geq 7$ MeV and protons with $E_p \geq 600$ MeV with one energy threshold, and electrons with $E_e \geq 15$ MeV and protons with $E_p \geq 1000$ MeV with the other threshold. At the end of December 1966 and beginning of 1967, on L shells ($L = 2.8 \pm 0.2$) that were clearly in the region of existence of trapped radiation (minimum height of drift trajectories $H_{min} \geq 800$ km), threshold I showed an increased counting rate in comparison with the cosmic-ray background, whereas no excess over the background was observed at threshold II. (WDM)

19398 PHYSICAL CONDITIONS IN THE MAGNETOSPHERE AND IN INTERPLANETARY SPACE DURING EXCITATION OF TYPE Pc1 GEOMAGNETIC PULSATIONS. Matveeva, E. T.; Kalisher, A. L.; Dovbnya, B. V. (Inst. of Earth Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 977-978(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1125-1126(1972).

Pulsations of Pc1 type (pearls) pertain to sporadic pulsations. It has been postulated that the pearl series are caused by electromagnetic signals excited during lightning discharges. However, this conclusion is based on an analysis of very limited material, and for this reason requires additional verification. It is the authors' view that the excitation of Pc1 occurs in cases where a certain set of physical conditions is realized inside the magnetosphere and in the interplanetary space near the magnetosphere. The character of these conditions is analyzed and described. (WDM)

19399 FAST INJECTION OF ENERGETIC PARTICLES INTO THE GAP BETWEEN THE INNER AND OUTER RADIATION BELTS. Kuznetsov, S. N.; Tverskaya, L. V.; Khorosheva, O. V. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 964-966(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1113-1114(1972).

It has been impossible to tell whether injection could take place at $L \lesssim 3$ during a single strong polar disturbance. An attempt is made to answer this question with the example of the strong storm ($D_{st} \approx -400\gamma$) of May 25–26, 1967, using continuous indirect ground measurements of fluxes of injected particles: data on auroral absorption of cosmic radio noise and on polar auroras. (WDM)

19400 MAGNETIC STORM OF MARCH 8–10, 1970, ACCORDING TO GROUND-BASED AND KOSMOS-321 OBSERVATIONS. Dolginov, Sh. Sh.; Zhigalov, L. N.; Strunnikova, L. V.; Fel'dshteyn, Ya. I.; Cherevko, T. N.; Sharova, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 909-918(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1046-1058(1972).

It has been established that the sources of the main part of the storm field are located beyond the ionosphere, above the satellite apogee. The actual existence of an ionospheric part of disturbance on the day side is discussed. The position of the disturbance region on the night side at high latitudes agrees well with that of the oval, determined from visual auroral observations with allowance for the intensity of polar magnetic disturbances and the magnitude of D_{st}-variations. The highest magnetic activity is found near the polar boundary of the oval. Intense field fluctuations in the near-polar region during the general field depression produced by the prehistory of the storm are reported. (auth)

19401 MODULATION OF AURORAL ELECTRON FLUXES AND GEOMAGNETIC PULSATIONS DURING THE STORM OF MARCH 8, 1970. Gasset, G.; Zhulin, I. A.; Cambou, F.; Kanonidi, Kh. D.; Kleymenova, N. G.; Raspopov, O. M.; Saint-Marc, A.; Treilhou, J. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 919-924(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1059-1066(1972).

A detailed comparison and analysis are presented of the results of synchronous measurements of x-ray bremsstrahlung (of an energy greater than 15 to 20 keV) during the flight of a high-altitude drifting balloon in Arkhangel'sk Province ($L \sim 3.8$) and of data on geomagnetic pulsations at Borok Observatory during the storm of March 8, 1970 (midnight sector), the most intense in the current solar activity cycle. The possible mechanism associating the generation of geomagnetic pulsations and the modulation of particle fluxes in the magnetosphere is discussed on the basis of the analysis. (auth)

19402 ACCELERATION OF CHARGED PARTICLES IN THE REGION OF THE NEUTRAL LINE OF THE MAGNETIC FIELD. Orazberdyyev, Kh.; Trakhtengerts, V. Yu. (Physical Technical Inst., Ashkhabad, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 925-927(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1067-1069(1972).

The acceleration of charged particles by the electric field near the neutral line of the magnetic field is investigated. Acceleration is computed in a model with a linearly varying magnetic field. The existence of two essentially different regions, i.e., the neutral sheet proper and the peripheral region, is demonstrated. Particle acceleration in one of the regions is accompanied by deceleration in the other. Some estimates referring to the tail of the magnetosphere are given. (auth)

19403 SOME STATISTICAL CHARACTERISTICS OF THE SPECTRA OF POLAR MAGNETIC SUBSTORMS. Turbin, Yu. G.; Vakulin, Yu. I.; Urbanovich, V. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 928-930(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 1070-1073(1972).

The results of a statistical analysis of data obtained from a spectral analysis of the H component of polar substorms having an intense irregular part are examined. It is found that the number of intensity bursts in various parts of the spectrum changes periodically and is grouped near T values that agree with the natural torsional vibrations of the Earth. In the short-period part of the spectrum this pattern is more distinct at latitudes of the auroral zone. (auth)

19404 PENETRATION OF SOLAR PROTONS INTO THE GEOMAGNETIC TAIL. Alekseyev, I. I.; Kropotkin, A. P.; Shabanskii, V. P. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 846-849(1972).

Translated from Geomagn., Aeron.; 12: No. 6, 974-978(1972).

A new mechanism is suggested for the penetration of solar cosmic-ray protons into the tail of the magnetosphere and ionospheric polar caps. In this mechanism, proton scattering on the magnetic inhomogeneities of the tail is regarded as a regular process rather than diffusion. Solar protons enter the neutral sheet on the morning side of the tail of the magnetosphere and then fill it completely. The delay time between the appearance of particles in the interplanetary medium and in the tail ranges from 10 min to 1 hour. (auth)

19405 IDENTIFICATION OF DISCONTINUITIES AT THE MAGNETOSPHERE BOUNDARY. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 850-854(1972).

Translated from Geomagn., Aeron.; 12: No. 6, 979-983(1972).

The types of magnetosphere boundary inhomogeneities were investigated from 49 crossings on seven spacecraft in 1961–1968. The predominance of tangential discontinuities, which account for ~70% of all cases, was confirmed. A group of discontinuities was found with a nonzero normal and collinear tangential magnetic field components, including discontinuities with a jump of the field magnitude and a change in sign of the tangential component. It was assumed that these latter discontinuities were anisotropic contact discontinuities. (auth)

19406 CLASSIFICATION, CHARACTERISTICS OF ORIENTATION, AND SOME EXAMPLES OF ROTATIONAL DISCONTINUITIES IN THE SOLAR WIND. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 6, 855-859(1972).

Translated from Geomagn. Aeron.; 12: No. 6, 984-988(1972).

Rotational discontinuities in a plasma with anisotropic pressure are divided into rotational shock waves, and rotational Alfvén, contact, and tangential discontinuities. It is found that the normal to the front of a rotational discontinuity is oriented at different angles to the directions $[F_1 \times F_2]$ and $[F_1 \times F_2] \times [F_2 - F_1]$, depending on the relative value of the normal magnetic field component and on the angle between field vectors ahead (F_1) and behind (F_2) the front. New examples of rotational Alfvén discontinuities are presented. (auth)

19407 FIRST MEASUREMENTS OF EARTH ALBEDO NEUTRONS IN SPACE. Place, J. R. Albuquerque, NM; Univ. of New Mexico (1972). 127p. University Microfilms Order No. 73-16,579.

Thesis (Ph.D.).

NASA satellite OSO-6 carried as part of its payload a proton recoil telescope capable of detecting neutrons between 40 and 200 MeV with directional discrimination. Sixteen months of data from this instrument were analyzed with a view to determining properties of the Earth albedo neutron flux above the atmosphere. The variation of albedo neutron flux with geomagnetic latitude was

found to be 1:4 between 0° and 40°. The angular distribution shows that about 40% fewer neutrons come upward from directly beneath the satellite compared to the number coming from a direction tangential to the top of the atmosphere. These results are in reasonable agreement with predictions. The energy spectrum between 50 and 150 MeV shows an intensity about a factor of 10 higher than had been predicted from extrapolation of lower energy calculations. These results are compared to other experiments, and their significance is discussed with regard to a neutron decay source for the inner radiation zone. (Diss. Abstr. Int., B)

PHYSICS (ATOMIC AND MOLECULAR)

Beams and Their Reactions

Refer also to abstract 19472.

19408 CROSS SECTIONS FOR ELECTRON CAPTURE BY FAST PROTONS IN HELIUM. Acerbi, E.; Birattari, C.; Candoni, B.; Castiglioni, M.; Cutrupi, D.; Dutto, G.; Succi, C. (Univ., Milan). Lett. Nuovo Cim.; 7: No. 11, 435-438(14 Jul 1973).

Measurements of the electron capture cross sections by protons in helium gas at 18 to 26 MeV carried out at the Milan AVF Cyclotron Laboratory are reported. The results obtained point out that the cross section falls off only a little more slowly than the E^{-6} curve at energies higher than 10 MeV and that the asymptotic dependence E^{-6} is approached if energy increases. (LBS)

19409 ENERGY COMPOSITION OF SECONDARY ION-ELECTRON EMISSION IN THE RANGE UP TO SEVERAL HUNDRED ELECTRON-VOLTS. Barbaszewski, T. (Jagellonian Univ., Krakow); Soszka, W.; Stepien, T. Acta Phys. Pol., A; A44: No. 1, 159-162(Jul 1973).

A study was made of the high-energy part of the energy spectrum of secondary electrons emitted from a gold polycrystal surface under the bombardment of 4-keV ions of noble gases. The energy spectrum was found to have a fine structure, which has been attributed to autoionization, neutralization and de-excitation of the Auger atoms in the target and primary ion beam. (auth)

19410 MEAN VELOCITY OF PARTICLES EJECTED FROM VARIOUS POLYCRYSTALLINE METAL SURFACES BY SPUTTERING WITH HIGH-ENERGY NOBLE GAS IONS. Krueger, W.; Scharmann, A. (Univ., Giessen, Ger.). Z. Phys.; 260: No. 5, 417-420(1973).

The mean velocity and its dependence on the ion energy were determined, and the former showed a characteristic decrease at a certain ion energy E_0 which is in accordance with a proposition of Seitz on the influence of inelastic energy losses. Additional measurements were carried out using a thermocouple as a universal radiation detector and they showed a corresponding increase in radiation power at the same energy value. (GE)

Atomic and Molecular Properties

Refer also to abstracts 17949, 19470, 20190, and 20658.

19411 TWO-ELECTRON ATOMS. I. The Zeeman Effect in the 2^3P and 2^3S_1 States of Helium. II. The Combined Zeeman and Stark Effects in the First Excited State of Positronium. Lewis, M. L. New Haven; Yale Univ. (1972). 143p. University Microfilms Order No. 73-14,590.

Thesis (Ph.D.).

In order to determine accurately the fine structure constant α from the fine structure of helium, experiments and calculations on the fine structure and Zeeman effect in the 2^3P_J state of helium are needed. The calculation of the g_J-factors are needed to compare theory and experiment. The Breit equation, when reduced to large components by standard techniques, contains Zeeman terms to order $(Z\alpha)^2\mu_0 H$. A series of numerical wave functions in a Hylleraas-basis are computed by the variational method. Matrix elements of the Zeeman Hamiltonian are calculated with ten wave functions containing up to 165 terms. The results are summarized by g'_S, the spin g-factor; g'_L, the orbital g-factor and g_X, the g-factor of certain tensor operators. The extrapolated values: $g'_S = g'_S = g_S - (80.46 \pm 0.01) \times 10^{-6}$, $g'_L + (10.6 \pm 0.4) \times 10^{-6}$ and $g = (-3.5 \pm 2.5) \times 10^{-6}$ are in rather good agreement with the experimental values of S. Lewis, Pichanick and Hughes: $g'_S = g_S - (76.0 \pm 2.4) \times 10^{-6}$, $g'_L = g_L + (3.8 \pm 9.0) \times 10^{-6}$ and $g_X = (4.0 \pm 25.0) \times 10^{-6}$. An improved calculation of the Zeeman effect in 2^3S_1 helium was in excellent agreement with the work of Perl and Hughes. A discrepancy exists between the theoretical value of g_J (He, 2^3S_1)/g_J (H, $1^2S_{\frac{1}{2}}$) $= 1 - 23.24 \times 10^{-6}$ and the experimental value of Brossel of $1 - (21.6 \pm 0.5) \times 10^{-6}$. This discrepancy is of the same order of magnitude and sign in both 2^3S_1 and 2^3P_1. Calculations of higher order terms and experiments to remeasure g_J (He, 2^3S_1) are in progress to explain these discrepancies. Positronium, the bound state of an electron and a positron, is an ideal system to test the theory of quantum electrodynamics. Relativistic corrections to the Zeeman and motional Stark effect in the first excited state and the ground state of positronium are calculated. The positronium Hamiltonian is composed of the Breit interaction, the Pauli Hamiltonian and the virtual annihilation interaction. Matrix elements of the properly reduced and transformed Hamiltonian yield the corrections to the Zeeman and motional Stark effect. Diagonalization of the 16×16 secular matrix gives the energy levels of the first excited state of positronium. The correction to the g-factor in the n = 2 state is $g'(n = 2) = g_e[1 - (5/96)\,\alpha^2 - (E/2m)]$ and in the ground state $g'(n = 1) = g_e[1 - (5/24)\,\alpha^2 - (E/2m)]$ where E is the kinetic energy of the atom. The correction to the motional Stark effect may be written as $\langle H_{STARK} \rangle = -\mu_0 \langle \vec{P} \times \vec{H} \cdot \vec{r} \rangle \gamma$ where $\gamma = 1 - (E/2m) + (7/288)\,\alpha^2$. The g-factors and γ include the maximum Stark effect normal to the magnetic field. A precision measurement of the ground state fine structure by the Zeeman effect requires the use of $g'(n = 1)$ calculated. (Diss. Abstr. Int., B)

19412 SYMMETRY OF THE ENERGY LEVELS OF THE HYDROGEN ATOM AND THE APPLICATION OF THE SYMMETRY TO THE CALCULATION OF RADIATIVE LEVEL SHIFTS. MacLay, G. J. New Haven; Yale Univ. (1972). 240p. University Microfilms Order No. 73-14,592.

Thesis (Ph. D.).

The classical and quantum mechanical equations of motion of the nonrelativistic hydrogen atom in configuration and momentum space are derived from symmetry considerations. The physical meaning of the symmetry transformations and the structure of the degeneracy group is discussed. In order to display the symmetries in quantum mechanics in the most elegant and uniform way a basis of eigenstates of the inverse of the coupling constant $(Z\alpha)^{-1}$ for a fixed energy is used. Using this basis the nonrelativistic wave functions are considered. The degeneracy in the Dirac hydrogen atom is briefly discussed deriving the expressions for the generators of the degeneracy group in terms of the canonical variables. The noninvariance or spectrum generating group of the hydrogen atom SO(4,1) and the enlarged spectrum generating group SO(4,2) are discussed. All physical states together form a basis for an irreducible representation of these noninvariance groups. Expressions are derived in terms of the canonical variables for the generators of the group transformations and the values possible for the Casimir operators are obtained. The shifts in energy levels due to the interaction of an electron with its own radiation field are considered. After discussing radiative effects in classical physics one turns to field theory and derives from the equations of motion an expression for the radiative shifts to first order in α for a spin zero particle in an external Coulomb potential. In the nonrelativistic or dipole approximation this form gives a level shift which contains an infinite sum over states of matrix elements of a rotation operator of an O(1,2) subgroup of the group SO(4,2). This sum yields the character of the representation. A single integral which is a generating function for the shift for any level in the nonrelativistic or dipole approximation is obtained. Then an expression to the first order in the radiation field is derived for the level shift for an approximately relativistic meson bound in a Coulomb field. (The approximation consists in dropping the potential squared term in the Klein–Gordon equation.) The dependence of the shift on the strength $(Z\alpha)$ of the potential is treated analytically, with no expansions in orders of $(Z\alpha)$. After expressing the shift in terms of SO(4,2) generators we can simplify using group theoretical results. The matrix elements required can be expressed as matrix elements of rotation operators of various subgroups, and calculated from the theory of representations. The complete semirelativistic radiative shift to all orders in $(Z\alpha)$ for the ground state is given by the sum of a term which may be viewed as the generalization of the Bethe logarithm plus some constant terms. (Diss. Abstr. Int., B)

19413 GROUND-STATE BINDING ENERGY OF THE ^{4}He TRIMER. Lim, T. K. (Department of Physics and Atmospheric Science, Drexel University, Philadelphia, Pennsylvania 19104). Phys. Rev. A 7: No. 5, 1798-1800 (May 1973).

Through a variational calculation, the ground-state binding energy of the ^{4}He trimer is computed using the ab initio potential of Bertoncini and Wahl. These results indicate a stable trimer bound by 0.3°K. (auth)

19414 EXPONENTIAL OR SCALED SCF ORBITALS IN CORRELATED WAVEFUNCTIONS FOR TWO-ELECTRON ATOMS. Carlton, Terry S.; Morrell, James A.; Arnow, David M. (Department of Chemistry, Oberlin College, Oberlin, Ohio 44074). J. Chem. Phys. 58: No. 10, 4092-4097 (15 May 1973).

Wavefunctions for the ground state of H^-, He, Li^+, and Be^{2+} are approximated by the product of orbitals with a correlation function. Use of optimally scaled SCF orbitals in place of fully optimized orbitals causes an additional energy error of at least 0.001 hartree. Exponential orbitals are superior to scaled SCF orbitals in open-shell cases or if the correlation function increases with $(r_1-r_2)^2$; otherwise SCF orbitals are superior. Application of correlation functions to open-shell wavefunctions causes the outer orbital to contract more than the inner orbital, which

actually expands slightly except at low atomic numbers. If the correlation factor depends on $(r_1-r_2)^2$ as well as r_{12}, the inner and outer exponential orbitals can become identical when Z is greater than 2. Several three-parameter wavefunctions have errors of 0.0010–0.0018 hartree. Good approximations to completely flexible correlation functions of r_{12} alone are $1-Aexp(-Br_{12})$ and $(1+Ar_{12})^C$. In the latter function and $[1+Ar_{12}+B(r_1-r_2)^2]^C$ the optimum C can be predicted accurately by extrapolation. (auth)

19415 HIGH PRESSURE OPTICAL STUDIES OF RARE EARTH IONS IN CaF_2 AND OTHER FLUORIDES. Wang, P. J.; Drickamer, H. G. (School of Chemical Sciences and Materials Research Laboratory, Univeristy of Illinois, Urbana, Illinois 61801). J. Chem. Phys. 58: No. 10, 4444-4446 (15 May 1973).

High pressure optical absorption studies have been performed on a series of rare-earth ions Sm^{2+}, Dy^{2+}, Sm^{2+}, and Tm^{2+} in CaF_2, Tm^{2+} in SrF_2, EuF_2, and Gd^{3+} in CaF_2. For the first five substances the transitions from the $4f^n$ ground state to the $4f^{n-1}$ 5d configuration shift to lower energy with increasing pressure. This is consistent with the 4f–5d electronic transitions observed or postulated in a number of rare-earth metals at high pressure. The impurity center introduced by gadolinium in CaF_2 has been shown to be a Gd^{3+} ion associated with a neighboring anion vacancy containing two trapped electrons. The shifts of the three peaks observed are consistent with the assignments of Alig. Two new absorptions are induced irreversibly by pressure. These behave very much like pressure-induced peaks in x-irradiated CaF_2 which have been attributed to electrons trapped at lattice imperfections. (auth)

19416 PRESSURE SHIFTS OF HIGH-SERIES SPECTRAL LINES AND CROSS SECTIONS FOR SCATTERING OF VERY SLOW ELECTRONS FROM RARE-GAS ATOMS. II. Choudhury, M. H.; Dunning-Davies, J. (Department of Applied Mathematics, The University of Hull, England). Phys. Rev. A 7: No. 5, 1549-1554 (May 1973).

In an earlier paper, one of the authors gave a completely quantum-mechanical treatment of the pressure shift, due to foreign atoms, of high-series spectral lines of alkali-metal atoms. The same basic method of solving the Schrödinger equation for the system using perturbation techniques is adopted again. However, in the present paper, the center-of-mass motion is treated separately, allowing the use of more realistic distribution functions when averaging over the center-of-mass motion of the foreign atoms. By using a Boltzmann-type distribution law, it is shown that, for foreign atoms exhibiting a red shift, the observed shift decreases with increase in temperature, but no analogous result is found for atoms exhibiting a blue shift. (auth)

19417 PRECISE HYPERFINE PRESSURE-SHIFT MEASUREMENTS FOR HYDROGEN ISOTOPES IN ARGON. Morgan, C. L.; Ensberg, E. S. (Physics Department, Yale University, New Haven, Connecticut 06520). Phys. Rev. A 7: No. 5, 1494-1502 (May 1973).

The pressure shift of the hyperfine splitting ν in the ground state of the hydrogen isotopes for an argon buffer gas has been measured with about 0.1% accuracy by an optical-pumping method with improvements in sample design, temperature control, and magnetic field stabilization. If the shift is expressed as $(1/\nu_0)(\delta\nu/\delta\rho) = A+B(T-T_0)$, the results for hydrogen, deuterium, and tritium are, respectively, $A_H = (-4.800\pm0.006)\times10^{-9}$ Torr^{-1} (0°C); $B_H = (+0.956\pm0.011)\times10^{-11}$ °C^{-1} Torr^{-1}(0 °C); $A_D = (-4.802\pm0.022)\times10^{-9}$ Torr^{-1}(0°C); $B_D = (+1.091\pm0.047)\times10^{-11}$°C^{-1} Torr^{-1}(0 °C); $A_T = (-4.795\pm0.012)\times10^{-9}$Torr^{-1}(0°C); $B_T = (+0.929\pm0.021)\times10^{-11}$°C^{-1} Torr^{-1}(0 °C); where the arbitrary reference temperature T_0=26 °C has been used in every case. The density ρ is quoted in units of Torr(0 °C), the equivalent of 3.536×10^{16} atoms/cm^3. The absence of isotope dependence supports existing theories of the shift and encourages comparison with the measurements of muonium hyperfine splitting. (auth)

19418 HIGH RESOLUTION STUDIES OF ELECTRON EXCITATION. 1. The 4S States of Helium and the Energy Scale. Heddle, D. W. O.; Keesing, R. G. W.; Kurepa, J. M. (York Univ., Eng.). Proc. Roy. Soc. (London), Ser. A; 334: No. 1596, 135-147(17 Jul 1973).

An electron monochromator using hemispherical deflecting electrodes and its application to the measurement of electron excitation functions is described. Excitation functions of the 4^1S and 4^3S states of helium for energies within about 1V of threshold are presented. A prominent peak is found in each function and its energy determined as; 4^1S 23.937 ± 0.007 ± 0.011 eV, 4^3S 23.939 ± 0.007 ± 0.009 eV, where the first limits represent a systematic error and the second are standard deviations of several determinations. (auth)

19419 MONTE-CARLO SIMULATION OF HYDROGEN-ATOM RECOMBINATION. Jones, A.; Rosenfeld, J. L. J. (Thornton Research Centre, Chester, Eng.). Proc. Roy. Soc. (London), Ser. A; 333: No. 1595, 419-434(26 Jun 1973).

Classical trajectory calculations were used to calculate the cross section (and hence the rate constant) for the recombination of hydrogen atoms on a third hydrogen atom, in the temperature range 500 to 6000 K. The model involves the stabilization of a quasi-bound molecule in an encounter with the third atom. The results indicate that the cross section for direct stabilization is small and insensitive to the relative velocity, whereas the cross section for exchange stabilization is large at low velocities and decreases rapidly as the relative velocity is increased. The calculated rate constant, although of the right order of magnitude at 500 K, does not exhibit the anomalous features previously observed experimentally at higher temperatures. (auth)

19420 CALCULATION OF IONIZATION POTENTIALS FOR ISOELECTRONIC SERIES OF H, He, Li, Be, B, C, N, O, F, Ne. Safronova, U. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 33: No. 5, 449-451(Nov 1972).

Translated from Opt. Spektrosk.; 33: No. 5, 813-816(Nov 1972).

The ionization potentials for isoelectronic series of a number of atoms are calculated using the theory of perturbation with respect to 1/Z. The experimental and theoretical values are compared. On the whole the difference does not exceed 0.1%. Methods for increasing the accuracy of calculation are discussed. (auth)

19421 REDUCED COULOMB GREEN'S FUNCTION. Swierkowski, L.; Suffczynski, M. (Inst. of Theoretical Physics, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 21: No. 3, 285-287(1973).

The reduced Coulomb Green's function for the discrete levels of the hydrogen atom is computed. (auth)

19422 ELECTRONIC SPECTRA OF $Es^{3+}(5f^{10})$. Calculated Spectroscopic Parameters and the $f^{9,10}$ Spin-Orbit Coupling Diagram. Varga, L. P. (Oklahoma State Univ., Stillwater); Baybarz, R. D.; Reisfeld, M. J.; Mann, J. B. J. Inorg. Nucl. Chem.; 35: No. 7, 2303-2310(Jul 1973).

Based on ab initio calculations of the free-ion spectroscopic parameters, F_2 and ζ, for all plausible oxidation states of the actinides, extrapolations were made to the corresponding parameters for Es^{3+}. Using these starting parameters, the $f^{9,10}$ intermediate spin-orbit coupling diagram was constructed, and initial spectroscopic assignments to the experimental energy levels for Es^{3+} were derived from the diagram. Ten absorption maxima for 1.2×10^{-3} M ^{253}Es(III) in 1 N $HClO_4$ (1 cm cells), and one fluorescence level from an earlier preparation were fitted with the parameters E^1 = 3800, E^2 = 23.76, E^3 = 386.4 (F_2 = 273), and ζ = −4198 cm^{-1}, with the r.m.s. = 145 cm^{-1}. Alternate interpretations of the spectra are discussed. (auth)

19423 ELECTRONIC SPECTRA OF THE $5f^5$ AND $5f^9$ ACTINIDES: Am^{4+}, Pu^{3+}, Bk^{2+}, Cf^{3+}, AND Es^{4+}. The $f^{5,9}$ Intermediate Spin-Orbit Coupling Diagram. Varga, L. P. (Oklahoma State Univ., Stillwater); Baybarz, R. D.; Reisfeld, M. J. J. Inorg. Nucl. Chem.; 35: No. 8, 2775-2785(Aug 1973).

Ions of the f^5 configuration include Sm^{3+} in the lanthanide series and Pu^{3+} and Am^{4+} in the actinide series. Ions of the complementary f^9 electronic configuration include Dy^{3+} in the lanthanide series, and Cf^{3+} and the postulated Bk^{2+} and Es^{4+} in the actinide series. Further attempts at the interpretation of the f-f electronic spectrum of solid AmF_4 are described, the first attempts at interpretation of the absorption spectrum of aqueous Am^{4+} (in KF), and the first interpretations of the spectra of solid PuF_3 and of $^{249}Cf^{3+}$ in $DC1O_4$–D_2O which include the lowest-lying f-f electronic energy levels above the ground state. All spectra were obtained at ambient temperatures. Based on the $f^{5,9}$ intermediate spin-orbit coupling diagrams, and estimates of spectroscopic parameters, the spectra of Bk^{2+} and Es^{4+} are predicted. (auth)

19424 ELECTRONIC SPECTRA OF $5f^6Cm^{4+}$ AND $5f^8Bk^{3+}$. Prediction of $5f^6Cm^{2+}$ and Cf^{4+} Spectra from the $f^{6,8}$ Spin-Orbit Coupling Diagram. Varga, L. P. J. Inorg. Nucl. Chem.; 35: No. 8, 2787-2794(Aug 1973).

Based on ab initio calculations and experimental estimates of the free-ion spectroscopic parameters, F_2 and ζ, for f^6Sm^{2+}, Eu^{3+}, and Am^{5+}; f^8Gd^{2+}, Tb^{3+}, and Dy^{4+}, the $f^{6,8}$ intermediate spin-orbit coupling diagram was constructed. In spite of the high density of states in the medium energy region of the possible 295 free-ion f-f transitions, it was found that the low energy levels were well spaced and identifiable. Nine low energy levels of Cm(IV) and up to thirteen low energy levels of $^{249}Bk^{3+}$ obtained from room temperature absorption spectra were analyzed to obtain the corresponding spectroscopic parameters. The values of F_2 and ζ for Cm(IV) were found to be 276 and 3103 cm^{-1}, respectively. The preferred values for Bk^{3+} were F_2 = 269 and ζ = −3160 cm^{-1}. The ordering of spectroscopic terms for Cm^{2+} and Cf^{4+} free-ion f-f spectra was predicted from the spin-orbit coupling diagram. (auth)

19425 LIFETIMES AND INITIAL POPULATIONS OF FOIL-EXCITED HYDROGEN AND LITHIUM STATES. Bukow, H. H.;

Buttlar, H. V.; Haas, D.; Heckmann, P. H.; Holl, M.; Schlagheck, W.; Schuermann, D.; Tielert, R.; Woodruff, R. (Univ. Bochum, Ger.). Nucl. Instrum. Methods; 110: 89-94(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

Ion beams of hydrogen and lithium are accelerated to energies of 50 to 400 keV and sent through a thin carbon foil. The decay of hydrogen states is observed by recording light intensities as a function of distance behind the foil. Two detectors are used simultaneously to measure Lyman-α and Balmer lines. They consist of an interference filter with cooled multiplier and an MgF_2 filter with channeltron, respectively. A correlated fit of both decay curves allows satisfactory elimination of cascade effects and yields an experimental lifetime for Ly-α of (1.592 ± 0.025) ns. The main error results from uncertainties in the beam velocity. The initial state populations obtained using H_2^+ and proton beams show significant differences which may be of interest concerning the ion-foil interaction problem. The lithium spectrum is measured between 400 and 1500 Å using a $^6Li^+$ beam viewed by a 0.5 m Seya–Namioka VUV monochromator with a channeltron detector. In this range, all known Li II transitions are found and most of them are investigated for lifetimes, cascades, and initial state populations. Also lines in the hydrogen-like Li III spectrum are observed, equivalent to H_α through H_δ. Their decay curves reveal the existence of a long-lived cascade which is believed to originate from an autoionizing state of Li^+. (auth)

19426 LIFETIME MEASUREMENTS OF DOUBLY EXCITED STATES OF HELIUM. Knystautas, E. J.; Drouin, R. (Univ. Laval, Quebec). Nucl. Instrum. Methods; 110: 95-97(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

Beam-foil spectra of helium taken in the region 280 to 350 Å show several lines belonging to two-electron excitation states, including some previously unreported ones. Lifetime measurements of some of these levels are made using the stronger lines. Results are compared with recent theoretical calculations by Drake and others. Preliminary results are also presented on helium-like boron. (auth)

19427 THEORY OF RARE EARTH ENERGY LEVELS AND SPECTRA. Cowan, R. D. (Los Alamos Scientific Lab., NM). Nucl. Instrum. Methods; 110: 173-182(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

The characteristic properties of rare earth atoms and ions are consequences of the existence of a tightly-bound 4f orbital, beginning at atomic number 57. The ground and low-excited configurations of these atoms are comprised of unfilled 4f, 5d, 6s and 6p shells, and for the most part are exceedingly complex. Certain simplifications in the level structure and spectra do exist when no 5d electrons are present, because the 4f–6s and 4f–6p interactions are comparatively weak. However, new complications arise at high ionization stages because 5p electrons may be removed before all 4f electrons have been exhausted. (auth)

19428 THEORY OF NON-STATIONARY STATES IN MANY-ELECTRON ATOMS. Nicolaides, C. A. (Yale Univ., New Haven). Nucl. Instrum. Methods; 110: 231-24 (1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

A useful classification of atomic states into "stationary" and "nonstationary" states with further subdivisions with respect to the rate of de-excitation is provided. The stationary states are defined to be the well known states observed by photon emission which have formed the basis for the conceptual development of quantum mechanics. The nonstationary states are defined to be those observed via electron emission and their properties are outlined. A general approach is presented which allows one to deal with them both conceptually and computationally. Certain similarities and differences from stationary states are pointed out. Inner-hole or doubly excited states, observed in various types of experiments, are treated from a conceptually single point of view, as decaying states. The relevant important quantities are derived and interpreted in a mathematically and physically meaningful way. Accurate total energies are calculated by employing a variational minimum principle which permits one to incorporate systematically the important correlation effects without the danger of a "variational collapse." This method requires projection onto known, zeroth order functions and it thus overcomes the difficulties of the well known P, Q methods which require projection onto exact wave functions. N-body calculations on three-electron atoms yield the He^- $2s^22p\ ^2P^0$ and $2s2p^2\ ^2D$ resonances, previously observed experimentally, at about 57.3 eV and 58.4 eV, as well as new resonances in Li I at about 141.7 eV ($2s^22p\ ^2P^0$), 144.9 eV ($2s2p^2\ ^2D$) and 62.0 eV ($1s2p^2\ ^2D$), in B III at about 204.7 eV ($1s2p^2\ ^2D$) and in C IV at 306.7 eV ($1s2p^2\ ^2D$). These states, which are just samples of states treatable by this approach, may in principle cause observable structures, e.g., in photon-absorption, in particle-atom scattering or in beam-foil experiments. (auth)

19429 MEASUREMENTS OF TRANSITION PROBABILITIES OF FORBIDDEN LINES OF NEUTRAL ATOMS AND MOLECULES. Corney, A. (Oxford Univ.). Nucl. Instrum. Methods; 110: 151-166(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

The importance of forbidden emission lines in the spectra of gaseous nebulae, aurorae, the airglow and the solar corona is emphasized together with the lack of reliable experimental lifetime measurements for most of these transitions. Several methods for forbidden lifetime measurements of neutral atoms and molecules are discussed and details given of the pulsed stationary afterglow and the thermal beam time-of-flight techniques. Results of lifetime measurements on metastable levels of helium, atomic oxygen, carbon monoxide and molecular nitrogen which decay by forbidden transitions are discussed. (auth)

19430 MEANLIFE MEASUREMENTS IN MANGANESE I AND II AND THULIUM II. Curtis, L. J. (Univ. of Toledo, OH); Martinson, I.; Buchta, R. Nucl. Instrum. Methods; 110: 391-394 (1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

Radiative lifetimes in Mn I, Mn II and Tm II were measured from beam-foil spectra in the wavelength region 2500 to 5000 Å, using 249 keV Mn^{+++} and Tm^{+++} ions from the Stockholm electromagnetic isotope separator. Post-foil particle velocities were measured using an electrostatic energy analyzer. Transitions were selected for study on the basis of their previous use in the determination of solar photospheric abundances. The measured lifetimes in Mn I are 2 to 6 times longer than those inferred by the gf values of Corliss and Bozman, and in Mn II the lifetimes show a trend to be similarly longer than those inferred by the emission measurements of Warner. The results thus suggest an upward revision by 0.5 dex of the solar photospheric Mn abundance. Contrarily, our Tm II lifetimes are shorter than those inferred by the values of Corliss and Bozman, and suggest a reduction by 0.38 dex of the solar photospheric Tm abundance. (auth)

19431 SEPARATED OSCILLATORY FIELD MEASUREMENTS ON FAST HYDROGEN. Lundeen, S. R.; Yung, Y. L.; Pipkin, F. M. (Harvard Univ., Cambridge, MA). Nucl. Instrum. Methods; 110: 355-360(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

An analysis of the line shape obtained in separated oscillatory field measurements of the hydrogen n = 3 Lamb shift is presented. The nonideal interaction geometry is shown to be capable of producing line distortions on the order of 1% of peak quenching in such experiments on unstable levels. Other lineshape details of interest for precision work are explored. (auth)

19432 LAMB SHIFT MEASUREMENTS IN HEAVY IONS. Leventhal, M. (Bell Telephone Labs., Murray Hill, NJ). Nucl. Instrum. Methods; 110: 343-353(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

Recent experiments on the Lamb shift in hydrogenic heavy ions are compared with each other and with theory. The experiments are not yet good enough to test critically the latest Lamb-shift calculations. (auth)

19433 FINE STRUCTURE MEASUREMENTS AT THE n = 2 STATE OF HYDROGEN WITH THE QUANTUM BEAT METHOD. Andrae, H. J.; Dobberstein, P.; Gaupp, A.; Wittmann, W. (Physikalisches Institut der Freie Univ., Berlin). Nucl. Instrum. Methods; 110: 301-304(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

Quantum beats were observed in Lyman α emission (1216 Å) from hydrogen atoms formed by beam-foil interaction of proton beams. In the zero-field case, the $P_{\frac{1}{2}} - P_{\frac{3}{2}}$ fine structure separation (10 969 GHz) could be easily resolved and relative excitation cross sections for magnetic substates of the 2P level were derived from modulation amplitudes in the energy range from 50 to 270 keV. Applying a transverse magnetic field, coherent decay of 2P and 2S states was observed. Fourier transform of the measured intensity versus time curve was obtained showing three lines in coincidence with the calculated frequency spectrum. The possibility of determining the $S_{\frac{1}{2}} - P_{\frac{1}{2}}$ level separation (Lamb shift) from frequency ratios with great accuracy is discussed. (auth)

19434 HYPERFINE STRUCTURE MEASUREMENTS BY ZERO-FIELD QUANTUM BEATS AFTER BEAM-FOIL EXCITATION. Wittmann, W.; Tillmann, K.; Andrae, H. J. (Freie Univ., Berlin). Nucl. Instrum. Methods; 110: 305-310(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

Hyperfine structure measurements on n^3P states of ^{3}He I and ^{6,7}Li II with zero-field quantum beats are reported. A new nonlinear fitting technique is discussed which yields the magnetic hyperfine interaction constant $A(3^3P) = -0.1445 \pm 0.0004$ cm^{-1} completely independent of the beam velocity. In the ^{6,7}Li II case, A-values are determined from measurements on the 2^3P states which will serve as entries for the nonlinear fit of the 4^3P data in order to obtain the 4^3P fine structure separations. (auth)

19435 STARK BEATS IN LYMANN-BETA EMISSION. Alguard, M. J.; Drake, C. W. (Oregon State Univ., Corvallis). Nucl. Instrum. Methods; 110: 311-314(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

Intensity fluctuations in the emission of Lyman-β radiation from hydrogen atoms formed by beam-foil excitation were observed. A theoretical calculation of the intensity pattern is compared with the observed patterns to yield information about the initial density matrix of the atom. It is found that $\sigma_s/\sigma_p = 1.65 \pm 0.15$ at a particle energy of 255 keV. (auth)

19436 STARK EFFECT MODULATIONS IN He II AND Li III. Pinnington, E. H.; Berry, H. G.; Desesquelles, J.; Subtil, J. L. (CNRS, Villeurbanne, France). Nucl. Instrum. Methods; 110: 315-320(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

The intensity decays from terms of high principal quantum number in Li III (n = 7, 8, 9, 10) and He II (n = 5, 6, 7, 8) in a longitudinal electric field were observed. Strong modulations of up to 80% are superposed on the multiexponential decay curves. The frequencies correspond to the Stark-shifted energy splittings between levels of opposite parity. Fourier-transform techniques were used to deduce the frequencies observed, and we compare them with those obtained from the nonlinear Stark-effect theory of hydrogenic atoms by Lüders. By extrapolation to zero field measures of the fine-structure splittings were obtained. The observations are interpreted to give an understanding of which field geometries will produce such modulations and which fine-structure intervals will give rise to the major components of the observed modulation patterns. (auth)

19437 FINE AND HYPERFINE MEASUREMENTS IN LIGHT ATOMS. Berry, H. G.; Subtil, J. L. (Univ. Lyon, Villeurbanne, France). Nucl. Instrum. Methods; 110: 321-325(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

Alignment is discussed in terms of the beam-foil interaction, and it is shown how it can be used to reduce cascading in decay curves. The theory of modulated decays is introduced and is applied to fine structure measurements in ^{4}He I and hyperfine structure measurements in ^{6,7}Li II. Also the absolute wavelength of the $2s\ ^3S-2p\ ^3P$ transition in Li II was measured to obtain the first accurate measurement of a Lamb shift in a two-electron atom. (auth)

19438 DOUBLY-EXCITED STATES IN LIGHT ATOMS. Berry, H. G.; Desesquelles, J.; Dufay, M. (Univ. Lyon, Villeurbanne, France). Nucl. Instrum. Methods; 110: 43-50(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

The beam-foil technique appears to be an efficient excitation source for multiply-excited states of atoms and ions. Thus, it is found that doubly-excited and/or displaced term systems may often be more easily studied in this source than in others (e.g., the sliding and open spark, plasma discharges, etc.). Some relevant comparisons between these sources are made. Many new He I lines above 2000 Å were observed, and classifications as transitions between doubly-excited terms in He I are suggested. If a transition ends on an autoionization level of very short lifetime (10^{-14} s), a measurement of the observed linewidth can yield the autoionization rate of the lower level. Many classifications are also suggested within the Li I doubly excited doublet and quartet systems. Agreement with theoretical energies is not as good. Using a grazing-incidence spectrometer, observations of the doubly-excited states of the He I and Li I isoelectronic sequences were extended to heavier ions. (auth)

19439 DEPENDENCE OF THE OPTICAL POLARIZABILITY OF MOLECULAR HYDROGEN ON THE INTERNUCLEAR DISTANCE. Adamov, M. N.; Nezhentseva, E. V. Opt. Spectrosc. (USSR) (Engl. Transl.); 33: No. 5, 468-470(Nov 1972).

Translated from Opt. Spektrosk.; 33: No. 5, 850-853(Nov 1972).

The variation method of nonstationary perturbation theory was used to obtain the dispersion formula for the optical polarizability of molecular hydrogen at a number of fixed internuclear distances $0.8 \le R \le 2$ a.u. The unperturbed state of the system was described by a Weinbaum wave function. Four linear parameters in the latter function were varied. Numerical differentiation using the interpolation formula of Stirling gave the first and second derivatives of the static polarizability tensor at an internuclear distance R = 1.4 a.u. (auth)

19440 LINESHAPES AND TIME-WINDOWS: THEORY AND EXPERIMENT. Kay, L.; Lightfoot, B.; Harding, G. (Univ. Canterbury, Eng.). Nucl. Instrum. Methods; 110: 435-439(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

Factors which determine the shapes of emission lines in beam foil spectroscopy are discussed briefly and comparisons made between theory and experiment. Some novel experiments utilizing a diffraction grating within the target chamber are described, and a theory of "time-window" spectra is given. (auth)

19441 IMPROVED RESOLUTION METHODS FOR BEAM-FOIL SPECTROSCOPY. Hadeishi, T. (Univ. of California, Berkeley); Michel, M. C.; Yellin, J.; Geneux, E. Nucl. Instrum. Methods; 110: 445-451(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

In general, the resolution that can be achieved by conventional beam-foil spectroscopy is limited by the effects of cascading, spread in the beam velocity, beam divergence, and uncertainty in the beam velocity. A class of experiments is discussed which does not depend on these properties of the ion beams from low energy accelerators. It is believed that by proper choice of experimental conditions, extremely high precision can be achieved by the technique of beam-foil spectroscopy. (auth)

19442 SPECTRUM AND ENERGY LEVELS OF NEUTRAL THULIUM. Sugar, J. (National Bureau of Standards, Washington, DC); Meggers, W. F.; Camus, P. J. Res. Nat. Bur. Stand.; 77A: No. 1, 1-43(1973).

A new set of measurements of the spectrum of neutral thulium covering the range of 2513 to 11750 Å is given. The light source utilized for the observations was a microwave-excited thulium-iodide lamp. Second spectrum lines were recognized by comparing the output of this lamp with that of a 6A sliding spark. The results of Zeeman effect studies of these lines are included. Analysis of these new data led to the discovery of 348 new energy levels and provided revised values for the 142 already published. Measured Landé g factors are given for most of the levels. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstracts 19411, 19520, and 19976.

19443 (CNRS-CPT-73-P-516) FOURTH-ORDER VACUUM POLARIZATION CORRECTION TO THE POSITRONIUM HYPERFINE STRUCTURE. Owen, D. A. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Jan 1973. 5p. Dep. NTIS (U. S. Sales Only) $3.00.

The contribution of the fourth-order vacuum polarization correction to the annihilation diagram, to the positronium ground state hyperfine structure is evaluated. This leads to a reduction of 11.3 MHz to the previous theoretical prediction which greatly improves the agreement between theory and experiment. (auth)

19444 (CNRS-CPT-73-P-522) RECOIL CORRECTIONS TO THE MUONIC ATOM ENERGY LEVELS. Owen, D. A.; Calmet, J.; Barrett, R. C. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Mar 1973. 6p. Dep. NTIS (U. S. Sales Only) $3.00.

The Grotch and Yennie potential model and finite nuclear charge distributions are used to demonstrate that the energy levels of a two-body system exhibit a shift due to an additional recoil (other than that due to the reduced mass). The additional recoil contribution to the binding energy is expressed in terms of the binding energy, the latter including reduced mass corrections and 1st order vacuum polarization effects. The results obtained are applied to the case of muonic lead and compared with the values obtained by Fricke. (auth)

19445 RECALCULATION OF HFS CONSTANTS OF MUONIC ROTATIONAL NUCLEI. Meyer, J.; Ring, P. (Physik-Department der

T.U. München, Theoretisches Teilinstitut, 8046 Garching, Reaktorgelände, West Germany); Speth, J. Phys. Rev. A 7: No. 5, 1803-1805 (May 1973).

Magnetic hyperfine splittings of rotational levels in muonic deformed nuclei are calculated microscopically within the self-consistent cranking model, taking into account the finite extension of the nucleus. A previous oversight in the theory of the magnetic interaction between the muon and the nucleus is corrected. The splittings are found to be about 25% larger than the earlier estimates. These new values seem to remove the discrepancy between muonic and Mössbauer isomer shifts in the rare-earth region. (auth)

19446 DIFFRACTION EFFECT IN POSITRON ANNIHILATION. Hyodo, T. (Tokyo Univ.). J. Phys. Soc. Jap.; 34: No. 2, 476-478 (Feb 1973).

Several comments are given on the diffraction effect of annihilation gamma rays in a single crystal (cf. Hyodo et al., J. Phys. Soc. Japan 31(1971) 563). It is shown that the feature of this effect on the angular-correlation curve depends on the type of the apparatus. It is proved to be impossible to measure the momentum distribution of electron pairs along the direction strictly (within the error of less than a few milliradians) perpendicular to the lattice plane. The integrated intensity of the diffraction in copper was remeasured with better statistics. It agrees with the theoretical value within the experimental error of 5%. (auth)

Collision Phenomena

Refer also to abstract 26821.

19447 (AD-757505) LABORATORY STUDIES OF COLLISIONS OF ENERGETIC H (+) AND H WITH ATMOSPHERIC CONSTITUENTS. Report for January–November 1972. McNeal, R. J.; Birely, J. H. (Aerospace Corp., El Segundo, Calif.). 30 Dec 1972. Contract F04701-72-C-0073. 158p. (SAMSO-TR-73-87). NTIS.

An account of the current status of laboratory measurements applicable to the interaction of fast protons and hydrogen atoms with the earth's atmosphere is presented. Data are also presented for some gases found in the atmospheres of other planets. After a brief discussion of recent measurements of the auroral particle energy spectra in order to define the energy range for relevant laboratory measurements, the motion of energetic protons in the atmosphere is discussed to eludicate further the cross sections and quenching processes of interest. A review of ionization experiments follows with emphasis on data acquired in the last decade. Cross sections for excitation of the atmospheric target gases and fast hydrogen projectiles are then presented. Application of the data to auroral calculations is also discussed. (NTIS)

19448 (IAE–2175) EFFECT OF RESONANCE EXCITATION OF ATOMS ON CROSS SECTIONS OF ATOMIC COLLISIONS. Bortsaikin, S. M.; Kudrin, L. P.; Mikhailova, Yu. V. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 25p. (In Russian). INIS.

The cross sections of collision of resonance-excited atoms with atoms in their fundamental state are discussed in relation to the magnitude of resonance defects. The calculation of partial cross sections of slow collisions: $\sigma^{1,2}$ = the cross section of re-excitation, and σ^3 = the cross section of elastic scattering. Results were obtained by two independent methods: one called the method of variation of constants, and a second—the method of phase functions. It was shown that the known result of Stukelberg (sp?) for the primary excitation cross section is satisfactory only for sufficiently large resonance defects. (tr-auth)

19449 (LBL–1427) PARTIAL AVERAGING IN CLASSICAL S MATRIX THEORY; VIBRATIONAL EXCITATION TO H_2 BY He. Miller, W. H.; Raczkowski, A. W. (California Univ., Berkeley. Lawrence Berkeley Lab.). Apr 1973. Contract W-7405-eng-48. 15p. (CONF-730452-1). Dep. NTIS $3.00.

From molecular beam scattering conference; London, England, UK (16 Apr 1973).

Within the framework of a general semiclassical theory that combines exact classical dynamics and quantum superposition it is shown how a certain averaging procedure allows one to treat some degrees of freedom in a strictly classical sense while others are quantized semiclassically. This enormously simplifies the application of the theory to three-dimensional collision systems and also leads to an interesting formal structure in the theory: the quantum-like degrees of freedom are quantized semiclassically via use of double-ended boundary conditions, while the unquantized classical-like degrees of freedom enter only through a phase space average over their initial coordinates and momenta. Preliminary results for vibrational excitation of H_2 by He are presented and compared with available quantum mechanical calculations. (auth)

19450 (NRC-TT–1652) ELASTIC SCATTERING OF He ON LiF CRYSTAL SURFACES. Tsuchida, A. Translated by T. Wilds (National Research Council of Canada, Ottawa) from Nippon Kessho Gakkaishi; 14: 17-27(1972). 24p. Dep. NTIS (U. S. Sales Only) $3.25.

The diffraction strength of He on LiF crystal surfaces is obtained from a direct solution of a simultaneous differential equation showing the reciprocal partial wave relation. (JFP)

19451 (USCD–34-p-196-30) THEORETICAL STUDY OF ENERGY TRANSFER PROCESSES. Three Year Progress Report, November 1, 1970–October 31, 1973. Chen, J. C. Y. (California Univ., La Jolla, San Diego). 8 Jun 1973. Contract AT(04-3)-34. 12p. Dep. NTIS $3.00.

A summary of the progress of the work on low-energy atomic interaction, high energy atomic interaction, and intermediate nonadiabatic interactions is given together with comments on its significance in relation to the program objectives. The results of this work are reported in more detail in 18 scientific papers, 8 scientific conference reports, and 2 scientific reviews which are listed. (MHR)

19452 ELECTRON EXCITATION OF THE CALCIUM 4227-Å RESONANCE LINE. Ehlers, Vernon J.; Gallagher, Alan (Joint Institute for Laboratory Astrophysics, Boulder, Colorado 80302). Phys. Rev. A 7: No. 5, 1573-1585 (May 1973).

We have measured the optical-excitation function and polarization of the 4227-Å line, using crossed electron and calcium beams, for electron energies from threshold to 1400 eV. In the high-energy region, from 100–450 times the threshold energy, we have used the Bethe theory to normalize our experimental results. An excellent signal-to-noise ratio combined with ∼0.3-eV full width at half-maximum electron-energy resolution has enabled observation of structure in the excitation function and polarization curves below 5 eV. We observed a threshold polarization limit of (98 ± 3) %, consistent with the expected +100%. The data are also consistent with a logarithmic approach to a high-energy polarization of -100%. (auth)

19453 PRODUCTION OF He^+ IN He_2^+–He COLLISIONS NEAR THRESHOLD. Grossheim, T. R.; Leventhal, J. J. (Department of Physics, University of Missouri-St. Louis, 8001 Natural Bridge Road, St. Louis, Missouri 63121); Harris, H. H. Phys. Rev. A 7: No. 5, 1591-1594 (May 1973).

The relative cross section for production of He^+ in He_2^+–He collisions has been measured near threshold. Convolution integrals taking account of the thermal motion of the target He atoms are numerically calculated for several forms of the threshold cross section and compared to the data. For the threshold laws considered, threshold is in the range 2.0–2.4 eV, in agreement with theoretical values of the dissociation energy of $X\ ^2\Sigma_u^+\ He_2^+$. By using Liu's recent rigorous lower bound for this dissociation energy, a possible form of threshold law is obtained. The experiments also indicate that significant amounts of He_2^+ resulting from He^*–He interactions are formed in excited vibrational-rotational states of the $X\ ^2\Sigma_u^+$. (auth)

19454 STUDY OF THE REACTIONS $H_2^+ + He \rightarrow HeH^+ + H$ AND $HeH^+ + H \rightarrow H_2^+ + He$ USING CROSSED BEAM TECHNIQUES. Rutherford, J. A.; Vroom, D. A. (Gulf Radiation Technology, A Division of Gulf Energy and Environmental Systems Company, San Diego, California 92112). J. Chem. Phys. 58: No. 10, 4076-4079 (15 May 1973).

The proton transfer reactions $H_2^+ + He \rightarrow HeH^+ + H$ and $HeH^+ + H \rightarrow H_2^+ + He$ have been studied in the laboratory energy range 1–25 eV. The first process, which is endothermic for ground state reactants, has been studied over the indicated energy range with different degrees of vibrational excitation present in the H^+_2 particles. Below 9 eV, the reaction is found to depend strongly on vibrational energy while above this energy the reaction cross sections appear to depend mainly on the kinetic energy of the reactants. The exothermic reverse reaction exhibits a 1/v dependence in the low-energy region indicating an ion-dipole mechanism. Methods of measuring the degree of dissociation obtained in forming the hydrogen atom beam are discussed. (auth)

19455 ELASTIC SCATTERING OF ATOMS AND IONS. Powers, T. R. New Haven; Yale Univ. (1972). 89p. University Microfilms Order No. 73-16,379.

Thesis (Ph.D.).

Elastic collision cross sections were measured by a beam attenuation technique for the following systems and laboratory energy ranges. Hg and He, Ne, Ar, Kr, Xe at 200 to 1000 eV, K^+ and He, Ne, Ar, Kr, Xe at 40 to 1000 eV, and Na^+ and He, Ne, Ar, Kr, Xe at 40 to 1000 eV. The data were analyzed to yield interatomic potentials which are purely repulsive for all the Hg cases and the

alkali ion–He, Ne cases. In the scattering of alkali ions off the heavier rare gases, two term potentials including a contribution from the attractive ion–induced dipole forces are needed to fit the data. Semiclassical calculations of the total elastic cross section were used to investigate the effect of the long range retarded dipole interaction on atomic scattering. The case of He–He scattering was treated quantum mechanically. The effect of this interaction was found to be small except around the Ramsauer–Townsend minimum in the He–He cross section vs. energy curve. (Diss. Abstr. Int., B)

19456 THEORETICAL STUDY OF NONADIABATIC EFFECTS IN MOLECULAR COLLISIONS: THE $H^+ + H_2$ SYSTEM. Preston, R. K. New Haven; Yale Univ. (1972). 384p. University Microfilms Order No. 73-16,380.

Thesis (Ph. D.).

Approximate potential-energy surfaces for the two lowest singlet states of H_3^+ and the nonadiabatic terms which couple them are calculated using the diatomics-in-molecules with zero overlap approach. For excitation energies below 10 ev, nonadiabatic transitions must be confined almost entirely to a region localized at the avoided crossing of the two surfaces. The "trajectory surface hopping" model was developed to describe nonadiabatic effects in molecular collisions. It is an extension of the classical trajectory method that may be useful in treating many types of nonadiabatic molecular collisions. Using the TSH model, a large number of collisions are studied for the $H^+ + D_2$ and $D^+ + HD$ systems. Cross sections and distribution of final product dynamical variables are calculated and compared to recent experiments. The agreement is remarkably good especially since the theory is ab initio. The calculations reinforce earlier experimental conclusions that the reactions are characterized by small total cross sections and by efficient transfer of energy from reactant kinetic energy to product internal energy. The TSH model leads to an interesting conceptual view of chemical reaction in the $H^+ + H_2$ system. The description of electronic transitions and rearrangement of the nuclear configuration are unified under one comprehensive picture. (Diss. Abstr. Int., B)

19457 THEORY OF CASCADE EFFECTS ON LINE RADIATION PRODUCED IN ATOMIC COLLISION EXPERIMENTS. Wooten, J. W. Lincoln, NE; Univ. of Nebraska (1972). 120p. University Microfilms Order No. 73-15,407.

Thesis (Ph. D.).

A general theory of coincidence measurements when cascades are present is developed in a form especially applicable to atomic collisions. The equations incorporate the polarization of the radiation, the fine and hyperfine structure of the atomic levels, coherence of the radiation, time dependence of the intensity, cascade effects, and magnetic field effects. A general three level system with upper level collisionally excited is examined for three kinds of experiments: a scattered particle cascade photon coincidence experiment; a beam-foil experiment; and a double coincidence experiment. The cascade photon-scattered particle coincidence equation is found to agree with the previous result of Macek and Jaecks where the lower level was considered to be sharp. The field dependence of the radiation intensity is examined for beam-foil and double photon coincidence experiments. General equations are given for the use of the Hanle effect in measurements of line radiation from collisionally excited atoms. The possible use of the Hanle effect to measure the cross sections for charge exchange into the 3S and 3D states of hydrogen is discussed. (Diss. Abstr. Int., B)

19458 ELECTRON-IMPACT IONIZATION OF Ne AND Ar IN THE EIKONAL AND BORN APPROXIMATIONS. Wallace, S. J.; Berg, R. A.; Green, A. E. S. (Department of Physics and Astronomy, University of Florida, Gainesville, Florida 32601). Phys. Rev. A 7: No. 5, 1616-1629 (May 1973).

Utilizing the first Born approximation and an eikonal/closure approximation plus Bethe's generalized–oscillator–strength (GOS) formalism, we evaluate s- and p-shell ionization of Ne and Ar. Partial-wave contributions to the GOS are calculated using an analytic independent–particle model (IPM) whose parameters have been established in previous work on excitation GOS's. For single ionization of Ne and Ar shells (K shell excepted), total cross sections and cross sections differential in the energy of the secondary electron are calculated for electron–impact energies near threshold to 10 keV. The eikonal/closure approximation which is developed in detail for large atoms differs from the Glauber theory by not assuming sudden passage of the projectile in which the time dependence of the bound electron and the energy transfer to the projectile may be neglected. In the single-scattering limit, the theory produces a simple factor multiplying the usual Born approximation amplitude, which leads to improved agreement with experiment at low energy. (auth)

19459 POLARIZATION CORRELATIONS IN ATOMIC–FIELD BREMSSTRAHLUNG. Tseng, H. K.; Pratt, R. H. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). Phys. Rev. A 7: No. 5, 1502-1515 (May 1973).

Atomic bremsstrahlung–polarization correlations between incident electron and emitted photon are discussed for incident–electron kinetic energies in the range from 5 keV to 1 MeV. Results are reported from an exact numerical calculation in partial–wave formulation using screened potentials. It is shown that bremsstrahlung can be used as an analyzer of polarized electrons, a transmitter of polarization from electrons to photons, or a source of polarized radiation. Comparisons are made with previous work where available. (auth)

19460 ELECTRON EMISSION IN H_2^+–H_2 COLLISIONS FROM 0.6 TO 1.5 MeV. Wilson, W. E.; Toburen, L. H. (Battelle Northwest Laboratory, Richland, Washington 99352). Phys. Rev. A 7: No. 5, 1535-1544 (May 1973).

Cross sections, differential in emission energy and angle, have been measured for the ejection of electrons in collisions of H_2^+ ions with molecular hydrogen. Incident–ion energies studied were 0.6, 1.0, and 1.5 MeV and electron emission was measured over the laboratory angular range of 20°–125°. Electron–emission cross sections are compared with measurements for incident protons having the same velocity as the H_2^+ ions. Electron distributions attributable to dissociative ionization of the H_2^+ ion are integrated to obtain the total cross section for dissociative ionization. A comparison is made between measured differential cross sections for scattering the bound electron of the incident ion and cross sections for scattering of incident free electrons. (auth)

19461 EFFECT OF LONG–RANGE FORCES IN NEAR–RESONANT CHARGE TRANSFER: APPLICATION TO $He^+ + K$, Rb, and Cs. Olson, Ronald E.; Smith, Felix T. (Molecular Physics Department, Stanford Research Institute, Menlo Park, California 94025). Phys. Rev. A 7: No. 5, 1529-1535 (May 1973).

Near–resonant charge transfer in asymmetric collisions is often dominated by long–range forces due to polarization and sometimes to ion–quadrupole interactions. These interactions can lead to regions of strong coupling at large distances. The parameters necessary for estimating the cross sections by a modified Demkov formula (for strong coupling without crossing) can be obtained from a knowledge of simple atomic properties such as ionization potentials and polarizabilities. These formulas are applied to the calculation of the cross sections for the $He^+ + K$, Rb, and Cs asymmetric charge–transfer reactions and are compared with the experimental measurements of Peterson and Lorents. For these systems several inelastic channels are open and the theory predicts the relative abundances of the various excited states of He (n=2). (auth)

19462 SUDDEN APPROXIMATION APPLIED TO VIBRATIONAL INELASTIC SCATTERING: He–HD. Wartell, M. A. (Department of Chemistry, Metropolitan State College, Denver, Colorado 80204). J. Chem. Phys. 58: No. 10, 4700-4701 (15 May 1973).

19463 STUDY OF THE POTENTIAL CURVES OF XENON WITH OTHER RARE GAS ATOMS. Schneider, Barry (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). J. Chem. Phys. 58: No. 10, 4447-4451 (15 May 1973).

The model for the forces between closed shell atoms recently developed by Gordon and Kim is applied to the ground state potential energy curves of Xe–Xe, Xe–He, Xe–Ne, Xe–Ar, and Xe–Kr. Agreement between experimentally determined values of the distance between the nuclei at the potential minimum and the depth of the potential well is quite good considering the simplicity of the calculation. (auth)

19464 HIGH–ENERGY K–SHELL IONIZATION BY HEAVY PROJECTILES. Doolen, G. D.; McGuire, J. H.; Mittleman, M. H. (Department of Physics and Cyclotron Institute, Texas A and M University, College Station, Texas 77843). Phys. Rev. A 7: No. 5, 1800-1803 (May 1973).

The ionization of K–shell electrons by heavy particles is examined in the energy region where the projectile is moving faster than the orbiting electron. An explanation suggested for the rise of the experimental results above the Born approximation is the mechanism of "charge exchange to the continuum". An estimate of the effect shows reasonable agreement with experiment. (auth)

19465 EXCITATION OF ATOMIC NITROGEN BY ELECTRON IMPACT. Stone, E. J.; Zipf, E. C. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15213). J. Chem. Phys. 58: No. 10, 4278-4284 (15 May 1973).

Absolute cross sections have been measured for the excitation of the NI(λλ1134 1164, 1168, 1200, 1243, and 1743 Å multiplets by electron impact on atomic nitrogen. The λ1134, and λ1200 Å cross sections are large, reaching 2.0×10^{-16} and 2.5×10^{-16} cm^2 at their peaks, respectively. The magnitude of these cross sections is about a factor of two lower than the values reported previously by the authors, due to the discovery

of a fault in the apparatus. The presence of vibrationally excited molecular nitrogen in the discharged gas is confirmed and its effect on the measurements is discussed. The ratio of the oscillator strengths of the λ1200 and λ1134 Å resonance transitions is measured to be 2.6±0.3. The branching ratio for the NI(λ1131Å/λ1164Å multiplets is measured to be 2.8±0.3. Striking differences in the distribution of intensity between the spectra of atomic nitrogen and molecular nitrogen excited by energetic electrons suggest an optical method for measuring the density of atomic nitrogen in the upper atmosphere. (auth)

19466 EXCITATION OF FORBIDDEN TRANSITION IN HELIUM BY ELECTRON IMPACT AT KINETIC ENERGIES OF 300–500 EV. SINGLET–TRIPLET TRANSITIONS AT HIGH KINETIC ENERGY. Skerbele, Ausma; Harshbarger, William R.; Lassettre, Edwin N. (Center for Special Studies and the Department of Chemistry, Mellon Institute of Science, Carnegie–Mellon University, 4400 Fifth Avenue, Pittsburgh, Pennsylvania 15213). J. Chem. Phys. 58: No. 10, 4285-4289 (15 May 1973).

The transition $2^3S–1^1S$ in helium has been studied by electron impact over the kinetic energy range 300–500 eV. The ratio σ_T/σ_S of scattered current for this transition to that for $2^1S–1^1S$ is a maximum at scattering angle θ of 0°. The intensity ratio decreases with increasing θ to a minimum (which is below background) and then increases again to barely observable levels at $\theta \geq 12°$. At $\theta = 0°$ the ratio exceeds all presently developed theories by at least two orders of magnitude. At $\theta \geq 12°$ the ratio agrees approximately with the Born–Oppenheimer formula for exchange scattering. The ratio of cross sections for the transitions $2^1S–1^1S$ and $2^1P–1^1S$ has been determined over the range $\theta = 5°$ to 20°. Up to 15°, agreement with the Born approximation is good. Agreement is poor (25%) at $\theta = 20°$. (auth)

19467 LOW-ENERGY ELASTIC DIFFERENTIAL SCATTERING OF He^{++} BY He. Lam, S. K.; Doverspike, L. D.; Champion, R. L. (Department of Physics, College of William and Mary, Williamsburg, Virginia 23185). Phys. Rev. A 7: No. 5, 1595-1601 (May 1973).

The relative elastic differential scattering cross section for the He^{++}+He system has been measured for collision energies in the range $4 \leq E \leq 75$ eV. The experimental results have been analyzed utilizing semiclassical techniques based on a two-state model to obtain information about the intermolecular potentials for the $B^1\Sigma_u$ and $E^1\Sigma_g$ states of He_2^{++}. These results are discussed in terms of existing ab initio calculations for these two states. (auth)

19468 STUDY OF THE L- AND M-SHELL X RAYS OF Pb PRODUCED BY 0.5–14.0-MeV-PROTON BEAMS. Busch, C. E.; Baskin, A. B.; Nettles, P. H.; Shafroth, S. M. (University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27514); Waltner, A. W. Phys. Rev. A 7: No. 5, 1601-1606 (May 1973).

The L and M x rays of Pb were observed with a Si(Li) detector of 190-eV resolution for a 6-keV x-ray line. Absolute shell-ionization cross sections were derived and compared to plane-wave-Born-approximation (PWBA) and binary-encounter-approximation (BEA) predictions. The agreement between theory and experiment was generally good for both cross sections and x-ray ratio predictions. For proton energies less than 3 MeV the $L\alpha/L\beta$ and $L\alpha/L\gamma$ ratios display deviations that are qualitatively predicted by both theories but only absolutely reproduced by the PWBA result for $L\alpha/L\beta$. The $L\alpha/Ll$ ratio exhibits a minimum in the proton energy range 0.5–3.0 MeV that is not predicted by a single-ionization-state process. (auth)

19469 NONITERATIVE INTEGRAL-EQUATION APPROACH TO SCATTERING PROBLEMS. Smith, Ed R.; Henry, Ronald J. W. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). Phys. Rev. A 7: No. 5, 1585-1590 (May 1973).

A procedure which allows for both open and closed channels with exchange and orthogonality is formulated for a multichannel scattering process. Noniterative integral-equation theory is used to solve the coupled integrodifferential equations of the scattering problem from zero out to some transformation point where the reactance matrix is projected out to its asymptotic value by using a matrizant technique. The method is applied to a two-channel model which has some of the features of a 1s-2p approximation for e-H scattering. (auth)

19470 ANGULAR DISTRIBUTION IN THE TWO-QUANTUM ATOMIC PHOTOEFFECT. Arnous, E.; Klarsfeld, S.; Wane, S. (Institut de Physique Nucléaire, Division de Physique Théorique, 91406 Orsay-France). Phys. Rev. A 7: No. 5, 1559-1568 (May 1973).

Total and differential two-photon ionization cross sections are derived in the framework of perturbation theory, assuming a simple one-electron atomic model. It is shown that for an unpolarized target the angular distribution of the ejected electrons has the general form $a+b\cos^2\theta+c\cos^4\theta$, whatever the quantum numbers n, l, of the initial energy level, and the state of polarization (linear or circular) of the incident radiation. The total transition rates for circularly and for linearly polarized light are quite different from each other. For an arbitrary nl state, the theoretically allowed maximum value of their ratio is 3/2. Further analytical and numerical results are presented for hydrogen. The Appendix contains several useful summation formulas for spherical harmonics. (auth)

19471 COMPTON SCATTERING OF HIGH-ENERGY ELECTRONS FROM HELIUM. Wellenstein, H. F.; Bonham, R. A. (Department of Chemistry, Indiana University, Bloomington, Indiana 47401). Phys. Rev. A 7: No. 5, 1568-1572 (May 1973).

The electron–impact energy–loss spectrum of He at a scattering angle of 7° has been measured with an energy resolution of 2.7 eV fwhm using 25-keV incident electrons. A binary–encounter approximation was used to obtain the electron Compton profile from the cross–section differential with respect to both the energy loss of the incident electron and solid angle of the scattered electron $d^2\sigma/dEd\Omega$. The electron Compton profile was corrected for interference scattering from pairs of target electrons and exchange. It was then compared to theoretical and x–ray experimental values for the Compton profile. The effects of background, multiple scattering, and energy resolution are discussed. The electron–impact and x–ray methods for measuring Compton profiles are compared. (auth)

19472 SPIN POLARIZATION IN PROTON–KRYPTON CHARGE–EXCHANGE COLLISIONS. Shakeshaft, R.; Macek, J. (Behlen Laboratory of Physics, University of Nebraska, Lincoln, Nebraska 68508). Phys. Rev. A 7: No. 5, 1554-1559 (May 1973).

In proton–krypton charge–transfer collisions hydrogen is produced in the ground state and the krypton ions are preferentially populated in the ground ($^2P_{3/2}$) state when the protons are incident at about 100 eV. The preferential population of $Kr^+(^2P_{3/2})$ over $Kr^+(^2P_{1/2})$ means that the hydrogen atoms will emerge spin polarized. We have calculated the spin–polarization fraction at 100 eV as a function of impact parameter and as a function of scattering angle, and the results are reported in this paper. A comparison of these results with the results of previous calculations of proton–xenon charge transfer indicates that the latter process is more suitable for producing spin–polarized hydrogen, at least for small scattering angles. (auth)

19473 ELECTRONIC AND ATOMIC COLLISIONS. Volume II. Eight ICPEAC Conference, Belgrade, Yugoslavia, July 16–20, 1973. Cobic, B. C.; Kurepa, M. V. (eds.). Belgrade; Institute of Physics (1973). 470p. (CONF-730709–(P2)).

There are 222 abstracts presented on atomic collisions. (JFP)

19474 ELECTRONIC AND ATOMIC COLLISIONS. Volume I. Eighth ICPEAC Conference, Belgrade, Yugoslavia, July 16–20, 1973. Cobic, B. C.; Kurepa, M. V. (eds.). Belgrade; Institute of Physics (1973). 574p. (CONF-730709–Abst. (P1)).

There are 279 abstracts presented on atomic collisions. (JFP)

19475 IONIZATION IN PROTON–HYDROGEN ATOM COLLISIONS. Mukherjee, S. C.; Chowdhury, S. M. M. R. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 7: No. 14, 629-632(4 Aug 1973).

A theoretical calculation for a proton incident on a hydrogen atom is proposed based on a recently developed Coulomb-projected Born approximation theory. In the construction of the continuum state wave function of the ejected electron, proper account of both nuclei is taken. The theory does not distinguish the scattered proton from the target proton and takes account of the long-range Coulomb effect of the scattered proton. (JFP)

19476 NITROGEN MOLECULE DISSOCIATION FROM EXCITED ELECTRONIC STATES. II. Dissociation Under Electron Collision. Mamikonyan, E. R.; Polak, L. S.; Slovetskii, D. I. (Inst. of Petrochemical Syntheses, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 425-430(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 483-489(1972).

Calculation was made of the cross sections for excitation under electron impact of predissociated electronic-vibrational states of the nitrogen molecule. It was found that excitation of these states with subsequent spontaneous predissociation is the principal path for molecular dissociation under electron collisions in electron beams, and low-pressure gaseous discharges, and in the radiolysis of gaseous nitrogen. Analysis was made of the amount contributed by the various states to the overall dissociation rate constant and the variation of these effects with the mean electron energy and the population temperatures of the ground state vibrational levels of the molecule. (auth)

19477 EXCITATION OF ION LINES IN COLLISIONS OF ELECTRONS WITH THALLIUM ATOMS. Nipiipov, E. I.; Shimon, L. L. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 18: No. 4, 539-543(Apr 1973). (In Russian).

Excitation cross sections were measured for eighteen most

intensive ion lines of Tl II and Tl III (spectrum region 6000 to 2000 Å) excited in one action of mutual collision of incident electrons with thallium atoms. Energetic dependences of these cross sections within the energy intervals from the excitation threshold to 300 eV are obtained as well. The cross section magnitudes in maximum are 10^{-17} to 10^{-20} cm^2. Different kinds of excitation functions are observed within the limits of the most studied fundamental series of Tl II. Such difference within the limits of individual series is supposed to be due to interaction of the corresponding levels. The process of excited ion formation with pushing an electron out of the inner d-shell is established to proceed very efficiently in case of both single and two-fold ionization. (auth)

19478 EXCITATION CROSS SECTIONS FOR ELECTRON COLLISIONS WITH THE HIGHLY EXCITED HYDROGEN ATOM. Sobeslavsky, E. (VEB Kombinat Robotron, Dresden). Ann. Phys. (Leipzig); 28: No. 4, 321-332(1973). (In German).

The semiclassical method is suitable for calculation of transition matrices between highly excited states of hydrogen-like atoms, between highly excited exciton states, etc. This method is used in order to calculate Born collision cross sections for electron collisions with the excited hydrogen atom (n = 10, 15, 20 and $\Delta n = 1$) for s−s and s−p transitions. There is given an approximation for high energies according to which, for instance, the s−s cross section is proportional to $n^4 \cdot E^{-1}$. It is further shown that for high n and l only those electron-collision-induced transitions take place in which Δl is equal to Δn. A similar relation is true for the highly excited helium atom. There is given an approximation for the total cross section for the $n \rightarrow n'$ transition for the case of hydrogen. In addition, the matrix elements for transitions between continuum states are calculated for hydrogen. (4 figures, 1 table) (tr-auth)

19479 IONIZATION OF ENERGETIC NEUTRAL ATOMS ON A METALLIC SURFACE. Honzawa, T. (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 34: No. 2, 479-482(Jan 1973).

An experimental study is described of the ionization of energetic neutral atoms on an untreated, metallic surface. The energy loss associated with the ionization is found to depend strongly on the incident angle of the particles onto the surface. The efficiency of ionization is of the order of 10^{-6}. The angular distribution of the ions leaving the surface is also measured. (auth)

19480 K-SHELL IONIZATION BY C^+−C COLLISION IN THE keV−MeV ENERGY RANGE. Watanabe, T.; Koike, M.; Minami, F. (Tokyo Univ.). J. Phys. Soc. Jap.; 34: No. 3, 781-787(Mar 1973).

An application of Fano−Lichten's theoretical model for inner-shell ionizations is made to the case of C^+−C collision. K-shell vacancy production in C atom is interpreted as a result of electronic transition between quasimolecular levels of C_2^+ during collision. The interaction which causes the transition is considered to be the quick rotation of internuclear axis during collision. The calculated cross sections for K-shell ionization are in reasonable agreement with experimental data in absolute value as well as in their incident energy dependence. That is, one has found that the rotation of quasimolecular axis furnishes an appreciable value of matrix element for the electronic transitions. Some discussion is made on the physical properties which affect the process sensitivity. (auth)

19481 COMPARISON BETWEEN CROSSED-BEAM AND TARGET-GAS METHODS FOR STUDY ON OPTICAL EXCITATION FUNCTIONS IN ELECTRON-IMPACT OF H_2O. Tsurubuchi, S.; Iwai, T.; Horie, T. (Osaka Univ., Toyonaka, Japan). J. Phys. Soc. Jap.; 34: No. 2, 166-171(Jan 1973).

The so-called "crossed-beam method" and "target-gas method" are applied to the same events of molecular collisions. It is shown that the former method gives reliable information about the excitation functions for the OH band and the Balmer lines in dissociative and radiative collisions of H_2O with electrons, while the latter does not, at least, in the range of lower energies of incident electrons. (auth)

19482 AB INITIO CALCULATIONS ON INTERMOLECULAR FORCES. The Systems He−Hf and He−H_2O. Lischka, H. (Univ., Karlsruhe, Ger.). Chem. Phys. Lett.; 20: No. 5, 448-453(1 Jul 1973).

The interaction energy between a He atom and a polar molecule (HF, H_2O) is calculated with a Gaussian basis set both in the SCF approximation and with the inclusion of the intersystem correlation energy. The long range behavior of the interaction energy is compared with results from perturbation theory. (auth)

19483 BOUNDS ON MEAN EXCITATION ENERGIES: LAMB SHIFT, STOPPING POWER, STRAGGLING, AND GRAZING COLLISION OF HIGH-ENERGY CHARGED PARTICLE. Shimamura, I. (Tokyo Univ.); Watanabe, T. J. Phys. Soc. Jap.; 34: No. 2, 483-495(Feb 1973).

The complementary variational-bound theory for the dynamic polarizability, developed by Robinson, is extended to various mean excitation energies. The theory provides both upper and lower bounds on the mean excitation energy for the grazing collision of a fast charged particle with an atom or a molecule (I_{-1}), for its stopping power (I_0), for its mean fluctuation (I_1), and for the Lamb shift of an atomic energy level (I_2). Application to the 1s and 2s states of a hydrogen atom by use of 15-term trial functions yields bounds on $\ln I_{-1}$, $\ln I_0$, $\ln I_1$, and $\ln I_2$ with a relative error of the order of 10^{-7}, 10^{-5}, 10^{-8}, and 10^{-1}, respectively, if the I_k's are given in Rydberg units. An extrapolation procedure increases accuracy by about two orders of magnitude. (auth)

19484 X-RAY SPECTRAL STUDIES IN BEAM-FOIL SPECTRA. Oona, H., Bickel, W. S. (Univ. of Arizona, Tucson). Nucl. Instrum. Methods; 110: 497-502(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

X-ray spectra from both foil and solid targets are being studied. The x-rays are analyzed with either a bent crystal spectrometer using crystals of mica or lead stearate, or a solid state Si(Li) detector. The spectrometer contains a Bendix channeltron or a gas-filled proportional counter. The resolution of the crystal spectrometers is between 2 and 10 eV. Beams of argon have been sent through carbon foils of various thicknesses. In addition, beams of Ar^+, O^+, O_2^+, Ne^+, H^+, H_2^+ and H_3^+ were sent into thick targets of Cu, O, B, N, Li, F, C, Si, Al and Mg. The spectra from solid targets included broad peaks for incident heavy ions. The characteristics of those peaks depend on the target for a given incident beam. While these peaks were observed primarily with the Si(Li) detector, high resolution studies are now in progress with the crystal spectrometers. (auth)

19485 ELECTRON CAPTURE AND LOSS IN COLLISIONS OF H^+ AND H WITH Pb VAPORS. Baragiola, R. A.; Salvatelli, E. R. (Instituto de Fiscia, Rio Negro, Argentina). Nucl. Instrum. Methods; 110: 503-506(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

Cross sections for single and double electron capture by protons and electron capture and loss from hydrogen atoms in lead vapors were measured in the energy range 7.5 to 40 keV. The results on Pb are compared with those on Mg reported by other workers. Analysis of electron capture collisions is complicated by the presence of multiple pseudocrossings of potential energy curves, though it may be inferred that the role of electron capture from inner shells becomes increasingly important at velocities larger than 2×10^8 cm/s. The double electron-capture processes are best described assuming the validity of the rule of conservation of electronic spin in the collisions. (auth)

19486 CROSS SECTIONS FOR SINGLE AND DOUBLE ELECTRON CAPTURE FROM He^{++} ON HYDROGEN, NEON, AND ARGON. Baragiola, R. A.; Nemirovsky, I. B. (Universidad Nacional de Cuyo, Rio Negro, Argentina). Nucl. Instrum. Methods; 110: 511-513(1973).

From proceedings of the third international conference on beam-foil-spectroscopy; Tucson, Arizona (2 Oct 1972).

Cross sections σ_{21} and σ_{20} from doubly charged helium ions were measured in H_2, Ne and Ar. The measurements were performed in the velocity range 1.6 to 4.4×10^7 cm/s. $^3He^{++}$ was used as a projectile as $^4He^{++}$ could not be separated from background H_2^+ by magnetic deflection in the apparatus. Isotope effects are known to be negligible in this velocity range. Results obtained for the double electron-capture process at low energies indicate near resonant ($\Delta E \simeq 0$) types of collisions, which show that in the case of processes $He^{++} + X \rightarrow He + X^{++}$, where X is Ne or Ar, the recoiling doubly-charged ions are produced in highly excited states. Structure is observed in the cross sections versus velocity curves for collisions with Ne targets. (auth)

19487 HANLE EXPERIMENTS WITH ACCELERATED ION BEAMS IN GASEOUS TARGETS. Carre, M.; Gaillard, M.; Desesquelles, J. (Laboratoire de Spectrometrie, Villeurbanne, France). Nucl. Instrum. Methods; 110: 295-300(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

The alignment created by ion impact on gaseous targets can be used for atomic structure and collision process measurements both on the target and on the beam. The information gathered from magnetic depolarization curves as measured for different incident energies and different target pressures leads to a measurement of the products $g\tau$ (Landé factor by mean life) and $\sigma\langle v\rangle$ (relaxation cross section by mean velocity of secondary collision partners). Examples are given of the study of relaxation processes both in the low (recoiling target atoms) and high (accelerated ion beam) energy region. (auth)

19488 BEAM-FOIL-GAS SPECTROSCOPY. Bickel, W. S. (Univ. of Arizona, Tucson); Dufay, M.; Desesquelles, J.; Berry, H. G. Nucl. Instrum. Methods; 110: 69-73(1973).

From proceedings of the third international conference on beam-foil spectroscopy; Tucson, Arizona (2 Oct 1972).

When a foil is inserted into the beam of a beam-gas experiment, the beam excited state populations are driven far from their equilibrium beam-gas value. The time behavior of beam particle populations after the foil is governed by their radiative decay constants and collisional cross sections for production and destruction. The gas particle populations after the foil change in curious ways with distance from the foil because of changing beam-particle populations. This technique was used to compare excitation processes for foil and gas excited beams, study alignment and coherence destruction due to collisions, and measure collision destruction cross sections of states that are not formed in a beam-gas interaction. (auth)

19489 ERICSON FLUCTUATIONS IN THE $\pi^{\pm}$ SYSTEMS IN THE ENERGY RANGE 2 TO 3.5 GeV. Carlson, P. J. (CERN, Geneva). Phys. Lett., 45B, No. 2, 161-164(9 Jul 1973).

Existing data on $\pi^{\pm}$p total cross sections and 180° elastic differential cross sections in the energy range $2 < E_{cm} < 3.5$ GeV are used to estimate the fluctuating differential cross section within the statistical models of Ericson and Frautschi. A mass spectrum of the form $\rho(m) = a(m/m_0)^b \exp(cm)$ describes correctly the fluctuations observed in total cross sections and in 180° elastic differential cross sections. The mass spectrum is found to be denser for π^-p than for π^+p. (auth)

Atomic Theory

Refer also to abstract 19706.

19490 THEORY OF KLL AUGER ENERGIES INCLUDING STATIC RELAXATION. Shirley, D. A. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. A 7: No. 5, 1520-1528 (May 1973).

A previously overlooked relaxation energy R is introduced into the intermediate-coupling formulas of Asaad and Burhop to calculate the KLL Auger energies of the elements from Z=10 to 100. By employing the concept of equivalent cores, together with the work of Hedin and Johansson on polarization energies of electron holes, a method was developed to estimate R accurately from ground-state two-electron integrals calculated by Mann. These integrals were also used in the intermediate-coupling calculation. Agreement with experiment is excellent. A table of KLL Auger energies based on this work is given. These energies appear to be preferable to the older semiempirical values because they are comparable in accuracy and they have a sound theoretical basis. Their adoption for analysis of Auger spectra is suggested. The semiempirical values were based on two sets of parameters for light and heavy elements. They gave good fits only by using unrealistic values of the two-electron integrals in the intermediate-coupling equations, because the relaxation energy was omitted. In addition to predicting KLL Auger energies accurately, this work shows that the spin-orbit coupling constant ζ for 2p electrons in two-hole states is essentially the same as in one-hole states. The success of the intermediate-coupling calculations also shows that two-electron integrals in these two-hole states are accurately equal to those calculated for neutral atoms. The relaxation-energy concept can be applied to other problems. (auth)

19491 PROPOSED METHOD FOR COMPUTING DYNAMIC POLARIZABILITIES OF ATOMS. Sanders, William A. (Center for Molecular Dynamics and Energy Transfer, Department of Chemistry, The Catholic University of America, Washington, D.C. 20017). Phys. Rev. A 7: No. 5, 1515-1519 (May 1973).

It has been shown recently that static polarizabilities can be computed efficiently by solving the multiconfigurational self-consistent-field equations for an atom in the presence of a point charge which provides the polarizing field. The formalism developed here is designed to take advantage of these calculations in the computation of dynamic polarizabilities. The approach is basically equivalent to a perturbation method in which the unperturbed state is the statically polarized atom. The transition to the time-dependent problem is effected by introducing a potential function which turns off the static field and turns on a dynamic field with the desired time dependence. The spatial parts of the time-dependent wave function are represented by linear combinations of the statically polarized configurations, without explicit reference to the orbital model. (auth)

19492 MANY-BODY THOMAS-REICHE-KUHN SUM RULE. Krause, J. (Univ. of Chile, Santiago). Lett. Nuovo Cim.; 7: No. 14, 611-614(4 Aug 1973).

A decomposition technique for handling the many-body Schroedinger Hamiltonian is introduced, and the usefulness of this technique is illustrated by obtaining a generalized sum rule of the Thomas-Reiche-Kuhn type. A nonrelativistic system of N spinless interacting particles is considered. (JFP)

19493 THEORETICAL DETERMINATION OF $\alpha = e^2/\hbar c$ DEDUCED FROM ASYMPTOTIC GROUP INVARIANCE PROPERTIES OF HIGH ENERGY CHARGED DIRAC PARTICLES IN A CONSTANT EXTERNAL VECTOR POTENTIAL. Vigier, J. P. (Institut Henri Poincare, Paris). Lett. Nuovo Cim.; 17: No. 12, 501-506(21 Jul 1973).

It is shown how Wyler's formula for the determination of $\alpha^2 = e^2/\hbar c$ can be connected with asymptotic properties of high-energy electrons moving in a region of constant external electromagnetic potential. (LBS)

19494 NATURAL UNITS IN ATOMIC AND MOLECULAR PHYSICS. McWeeny, R. (Univ. of Sheffield, Eng.). Nature (London); 243: No. 5404, 196-198(25 May 1973).

In theoretical atomic and molecular physics it is often convenient to use atomic units; such units have various advantages. In the first place they are "natural" units, provided by naturally occurring quantities such as the magnitude of the electronic charge (e) and the "Rationalised" Planck constant ($h/2\pi$), and they are therefore independent of the practical units in terms of which their values can be assigned only by experiment. The charge on the electron does not depend on either measurement, or international agreement. Secondly, their adoption permits all fundamental equations to be written in a dimensionless form. Although atomic units have been widely used since the introduction by Hartree of the "double-Rydberg", and although the "Hartree" and the "Bohr" have been widely adopted as units of energy and length, no complete discussion of natural units appears to be available in the literature. A fairly complete list of natural units is given for all the most commonly encountered quantities in terms of fair base units, and some names are proposed for these units. The values of all are given in terms of practical international system (SI) units. Examples are given to illustrate use of the units in reducing complicated equations to a simple dimensionless form. (UK)

19495 HYPERFINE CONTACT INTERACTION IN LIGHT ATOMS. Sakibaev, R. S.; Safronova, U. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 33: No. 5, 447-448(Nov 1972).

Translated from Opt. Spektrosk.; 33: No. 5, 809-812(Nov 1972).

The contact term H_c of the Hamiltonian describing hyperfine splitting is discussed. Application of the theory of perturbations within terms of 1/Z made it possible to represent $\langle H_c \rangle$ in the form of a series in 1/Z for states of the multi-electron system $\langle H_c \rangle = (\alpha^2/3)(m/M)\, Z^3 a\{E_c^{(0)} + (1/Z)\, \Delta E_c^{(1)}\}$. Numerical results for $E_c^{(0)}$, $\Delta E_c^{(1)}$ are obtained for the configurations $1s2s$, $1s2p$, $1s^2 2s^n 2p^{n_2}$. (auth)

19496 MODIFIED FIRSOV'S COUPLING POTENTIAL FOR NEUTRAL ATOMS IN A GROUND STATE. Komarov, F. F. (Belorussian State Univ., Minsk). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 70-74(1973). (In Russian).

An analytical expression was obtained for the repulsive potential of atomic interaction. The calculated data agreed well with the experimental data and with the data of quantum mechanical computations for small and intermediate interatomic distances, and may be used for the study of problems dealing with the motion of heavy accelerated ions in matter. (tr-auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

19497 EXCEPTIONAL WAVES IN RELATIVISTIC MAGNETO-HYDRODYNAMICS. Greco, A. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 52: No. 4, 507-512(Apr 1972).

It is shown that in a perfect charged relativistic fluid with infinite conductivity the waves are completely exceptional, in the sense that shock waves do not arise, only if the fluid is incompressible. (tr-auth)

19498 DRAINING OF A POWERLAW LIQUID DOWN A VERTICAL PLATE IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Dutta, D. K. (Jadavpur Univ., Calcutta). Indian J. Theor. Phys.; 21: No. 1, 15-24(Mar 1973).

The motion of a powerlaw liquid under a magnetic field is considered. An analytical method has been developed to discuss the solutions for velocity profile and the rate of flow. From the discussion it is found that the effect of magnetic field damps the motion, whatever the type of powerlaw liquid considered. The problem has its importance in chemical engineering—in connection with evaporation, gas absorption experiments, application of coatings to paper rolls and wetted wall towers. (auth)

19499 COMPRESSIBLE MAGNETO-RELATIVISTIC FLOWS. Verma, B. G.; Srivastava, S. K. (Univ. of Gorakhpur, India). Def. Sci. J. (New Delhi); 22: 221-226(Oct 1972).

The character of compressible magneto-relativistic flow is investigated in subsonic, supersonic and transonic regions by applying the method of small amplitude disturbance solutions. Relations between the pressure coefficient free stream Mach number and Alfvén speed in these regions have also been obtained. (auth)

19500 MAGNETOHYDRODYNAMIC EKMAN LAYER. Gupta, A. S. Acta Mech.; 13: No. 1-2, 155-160(1972).

The effect of a uniform vertical magnetic field on the Ekman layer was studied over an infinite horizontal plate at rest relative to an electrically conducting fluid which is rotating with uniform angular velocity about a vertical axis. The induced magnetic field is neglected. Inertia terms vanish because of the assumed form of the velocity components. The interaction of the Coriolis force, viscous force and Lorentz force is studied. In view of the above assumptions, the problem reduces to the solving of a linear differential equation of second degree with constant coefficients. An analogy of this problem was drawn with the problem of a circular disk rotating with a uniform angular velocity in an electrically conducting liquid which also rotates with nearly the same angular velocity in the presence of a uniform magnetic field parallel to the axis of rotation. (App. Mech. Rev.)

19501 EFFECT OF HALL CURRENT ON TORSIONAL OSCILLATION OF DISK IN CONDUCTION FLUID SUBJECTED TO UNIFORM AXIAL MAGNETIC FIELD. Datta, S. 8: No. 23, 135-138(1971).

The exact analytical solution for the stated problem is shown. The viscous couple experienced by a disk of given radius is explicited given. (App. Mech. Rev.)

19502 RE-CONNEXION OF MAGNETIC LINES OF FORCE. Evolution in Incompressible MHD Fluids. Fukao, S. (Kyoto Univ.); Tsuda, T. Planet. Space Sci.; 21: No. 7, 1151-1178(Jul 1973).

Time-dependent incompressible MHD solutions in two dimensions are obtained numerically to study the evolutionary process involving a re-connexion of magnetic lines of force. Given an initial antiparallel magnetic field, or a current sheet, to which there is an injection of fluid in a transverse direction, it is shown how the process of re-connexion builds up. In this numerical experiment, special considerations are given to the confirmation of re-connexion, the formation of X-type magnetic field, the speed of growth, conditions that control the evolution, acceleration of particles, the structure of the diffusion region and so forth. The findings are: magnetic lines of force can re-connect and grow to the X-type configuration in fluids of any finitely large hydromagnetic and hydrodynamic Reynolds numbers; the conditions local to the neutral point are less important than the boundary conditions that set up global flow patterns; acceleration of fluid in bulk only concerns whether the X-type configuration grows to the comparably large extent or not; the electric field at the neutral point due to the rapidly changing magnetic field is less efficient in accelerating charged particles. (auth)

19503 MHD FREE CONVECTIVE FLOW IN A VERTICAL CHANNEL. Soundalgekar, V. M.; Haldavnekar, D. D. (Indian Inst. of Tech., Bombay). Acta Mech.; 16: 77-91(1973).

An analysis of the fully-developed MHD free convective flow between two vertical, electrically conducting plates was carried out. The effects of the external circuit, heat sources, and modified boundary conditions on the temperature at the nonperfect thermally conducting plates were studied. The nonlinear integro-differential equations, governing the flow, were solved by perturbation method. Velocity and temperature profiles were shown on graphs and the numerical values of other quantities are entered in tables. It is observed that the flow is stable at small values of M, the Hartmann number, whereas at large values of M, an increase in Φ_1 (the thermal conductance ratio) or λ (line heat source) leads to an instability of the flow. However, instability of the flow may be avoided by selecting the plates of high electrical conductivity. (auth)

19504 RIGID MOVEMENTS IN RELATIVISTIC MAGNETO-FLUIDDYNAMICS. Gheorghiev, G.; Ignat, M. (Univ., Iasi). Tensor; 25: 155-160(1972). (In Italian).

The geometry of a vector field is derived and rigid movements are defined. The fundamental equations of hydrodynamics and relativistic magnetofluiddynamics are given. The rigid movements in hydrodynamics and magnetofluiddynamics in the Rosen meaning are then described. (JSR)

19505 PARAMETRIZATION AND NON-UNIFORM SHOCK WAVES IN QUASI ONE-DIMENSIONAL NON-STEADY OBLIQUE FIELD MAGNETOGASDYNAMICS. Rogers, C.; Castell, S. P. Acta Mech.; 13: No. 3/4, 255-263(1972).

The primary parameters of nondissipative time-dependent conducting flows of a polytropic gas in which an oblique magnetic field is embedded are discussed. The continuity (mass conservation) equation and the Ampere equation allow the introduction of two "potential-like" functions that in turn can be expressed by functions defined by four first-order differential equations, plus two coupling equations and two integrability conditions. These latter equations may be integrated explicitly. It is shown that Gunderson's solution [AMR 23 (1970), Rev. 6586], for example, can be deduced by setting certain constants of integration equal to zero. The solutions can be used to determine the shock locus and the density distribution. Further, it is possible to generate new exact solutions to oblique field magnetohydrodynamics. (App. Mech. Rev.)

19506 DIRECT COMPUTATIONAL APPROACHES TO A MAGNETOHYDRODYNAMIC MODEL SYSTEM. Jeng, D. T. Computing; 7: No. 1/2, 1-12(1971).

The initial-value problem is solved numerically for the equations of a magnetohydrodynamic model system which constitutes a generalization of Burgers' equation and, hence, might be a useful basis for investigations on magnetohydrodynamic turbulence. Two different methods are used, their implications are discussed, and simple numerical examples are presented. No attempt is made to tackle the problem of turbulence formation. (App. Mech. Rev.)

19507 STEADY FLOW OF A NON-EQUILIBRIUM IONIZED GAS AROUND SHARP CORNERS IN THE PRESENCE OF A CROSSED MAGNETIC FIELD. Takashi, T. (Tokyo Metropolitan Univ.). J. Phys. Soc. Jap.; 34: No. 1, 232-246(Jan 1973).

The steady flow of a nonequilibrium ionized gas with an infinite magnetic Reynolds number past an insulated wall with sharp corners, in the presence of a crossed applied magnetic field, is studied in the linearized approximation. The speed of the flow is assumed to be larger than that of the fast magneto-hydrodynamic wave, and then the fundamental equation becomes purely hyperbolic, while the magnetic field in the wall is governed by the Laplace equation. Since the magnetic field should be continuous on the surface of the wall, disturbances propagate upstream of the first corner through the wall, and there is no uniform region in the flow field. In this case, the Laplace transform cannot be used and the Fourier transform is adopted. (auth)

19508 NUMERICAL STUDY BY THE METHOD OF CHARACTERISTICS OF THE INTERACTION BETWEEN A SUPERSONIC IONIZED ARGON CURRENT PRODUCED BY A SHOCK WAVE WITH ELECTRIC AND MAGNETIC FIELDS. Forestier, B.; Fontaine, B. (Institut de Mecanique des Fluides, Marseille). Compt. Rend., Ser. A, B; 276: No. 17, 705-708(25 Apr 1973). (In French).

Numerical studies of the interaction were realized using a method of characteristics applicable to the case of a unidimensional flow. The nonstationary character of the flow, the real gas effects, and the conductivity variations are considered. The analysis enables the formation and propagation of a shock wave reflected in the flow to be studied. (FR)

19509 CHANNEL FLOW OF AN ELECTRICALLY CONDUCTING PRANDTL–EYRING-FLUID IN A MAGNETIC AND AN ELECTRIC FIELD. Schroeder, P. (Technische Univ., Munich). Acta Mech.; 16: No. 1-2, 13-19(1973). (In German).

The magnetohydrodynamics of non-Newtonian fluids obeying the rheological law of Prandtl–Eyring is studied. The problem of steady state laminar flow in a flat channel is solved analytically. Results are presented for the shear stress and the velocity. Equations for calculation of pressure, magnetic field strength and density of the electric current are presented. For large characteristic numbers Kz there exists an analogy to the Hartmann flow of Newtonian fluids. (auth)

19510 MHD FREE CONVECTIVE FLOW IN A VERTICAL CHANNEL. Soundalgekar, V. M. (Indian Inst. of Tech., Bombay); Haldavnekar, D. D. Acta Mech.; 16: No. 1-2, 77-91(1973).

An analysis of the fully-developed MHD free convective flow between two vertical, electrically conducting plates was carried out. The effects of the external circuit, heat sources, and modified boundary conditions on the temperature at the nonperfect thermally conducting plates were studied. The nonlinear integro-differential equations, governing the flow, were solved by perturbation method. Velocity and temperature profiles were shown on graphs and the numerical values of other quantities are entered in tables. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 18979 and 19902.

19511 COMMENT ON QUARK CANDIDATES AMONG DELAYED SHOWER PARTICLES AT 70 MW(e) UNDERGROUND. Yock, P. C. M. (Univ. of Auckland, N. Z.). Lett. Nuovo Cim.; 7: No. 12, 470-472(21 Jul 1973).

A new interpretation is given of the experimental data of Dardo et al. (Nuovo Cimento, 9A: 319 (1972)), which suggests that the observed delayed shower particles may be abnormal for reasons other than the apparent values of their electric charges. (LBS)

Electromagnetic

19512 (AD-757587) ELASTIC ELECTRON-DEUTERON SCATTERING MEASUREMENTS AND THE NEUTRON CHARGE FORM FACTOR AT VERY LOW MOMENTUM TRANSFERS. Topping, R. L. (Naval Postgraduate School, Monterey, Calif.). Dec 1972. 154p. NTIS.

Thesis.

Seventy-five measurements of the differential elastic electron-deuteron scattering cross section were made for values of (q^2) ranging from 0.05 to 0.03 (fm^{-2}) at the NPS LINAC with electron scattering angles of 60° to 120°. The charge radius of the deuteron was determined to be (r_{Ed} = 1.9641 ± 0.0074 fm). Values of the neutron charge form factors were calculated using Lomon-Feshbach model 1, 5, and 15 relativistic corrections to the deuteron wave functions. (Auth Modified Abstract) (NTIS)

19513 (LA-tr-73-36) MEASUREMENT OF THE PION AND NUCLEON FORMFACTORS AT TIME-LIKE TRANSFERRED FOUR MOMENTUM VALUES OF $k^2 = 1.7f^{-2}$, $2.2f^{-2}$, AND $2.9f^{-2}$. Berezhnev, S. F.; Dem'ianov, A. V.; Kulikov, A. V.; Kuptsov, A. V.; Kurochkin, V. P.; Mkrtchian, G. G.; Nemenov, L. L.; Pustyl'nik, Zh. P.; Smirnov, G. I.; Fedunov, A. G.; Khazins, D. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1973. Translated by Anna Vakar (Los Alamos Scientific Lab., N. Mex.) from JINR-P1-6934. 16p.

The first experimental estimates of the nucleon form factor $F_1(k^2)$ in the time-like region were reported previously. These estimates as well as the estimates of the pion electromagnetic form factor $F_\pi(k^2)$ were obtained at the four-momentum transfer $k^2 = 2f^{-2}$ from the analysis of the data on the $\pi^- p \to e^+e^-n$ reaction in the Δ (1236) resonance region. An analysis of new data on the $\pi^- p \to e^+e^-n$ process is given. It is shown that theoretical description of the process in question in this particular region ($w = \sqrt{s}$ = 1295 MeV) is much simpler than that of photo- and electroproduction processes. Both the pion electromagnetic form factor $F_\pi(k^2)$ and the isovector Dirac-nucleon form factor $F_1^V(k^2)$ were assumed to be real in this region of small four-momentum transfers: $k^2 = 1.7f^{-2}$, $2.2f^{-2}$, and $2.9f^{-2}$. It is shown that the model fits all experimental distributions well in assumption of equality $F_\pi(k^2) = F_1^V(k^2)$. In this assumption the values of form factors at the above-mentioned four-momentum transfers are $F_\pi(k^2) = F_1^V(k^2) = 1.10 \pm 0.07$, 1.14 ± 0.06, 1.30 ± 0.07. The value of the electromagnetic radius in this case is $r_\pi = r_1^V = (0.75 \pm 0.14)f$ and is consistent with the value determined in the eN elastic scattering $r_{F_1^V} = 0.82f$. The parameters $F_\pi(k^2)$ and $F_1^V(k^2)$ being assumed independent, the determination of form factors is possible only at $k^2 = 2.9f^{-2}$: $F_\pi(k^2) = 1.2^{+0.3}_{-0.3}$, $F_1^V(k^2) = 1.4^{+0.3}_{-0.4}$. (auth)

19514 (LBL-1704) DETERMINATION OF THE AXIAL VECTOR FORM FACTOR IN THE RADIATIVE DECAY OF THE PION. Stetz, A.; Carroll, J.; Chirapatpimol, N.; Dixit, M.; Igo, G.; Nasser, M.; Ortendahl, D.; Perez-Mendez, V. (California Univ., Berkeley. Lawrence Berkeley Lab.). May 1973. Contract W-7405-eng-48. 28p. (CONF-730454-1). Dep. NTIS $3.00.

From symposium of the division of nuclear physics; Washington, District of Columbia, USA (23 Apr 1973).

Preliminary results on a measurement of the radiative decay of the pion, $\pi \to e\nu\gamma$ are reported. A metal-spark chamber spectrometer system and a 24-element hodoscope of lead-glass Cerenkov detectors are used to obtain positron momentum and positron-photon opening angle distributions. Using the theoretical distributions for the inner bremsstrahlung and the structure-dependent vector terms one can extract the axial vector contribution from the data. On the basis of 110 events the ratio of the axial vector to vector form factors, $\gamma = 0.11 \pm 0.07$ is found. (auth)

19515 (NP-19818) DARESBURY NUCLEAR PHYSICS LABORATORY ANNUAL REPORT, 1972. (Daresbury Nuclear Physics Lab. (England)). 1973. 131p. Dep. NTIS (U. S. Sales Only) $8.75.

Research on experimental high energy physics emphasizing electromagnetic interactions is summarized. A list of publications is included. (JFP)

19516 SEARCH FOR THE DECAY $\pi^0 \to 4\gamma$. Abrams, R. J.; Carroll, A. S.; Kycia, T. F.; Li, K. K.; Michael, D. N.; Mockett, P. M.; Rubinstein, R. (Brookhaven National Lab., Upton, NY). Phys. Lett., 45B: No. 1, 66-68(25 Jun 1973).

A search was made for the decay $\pi^0 \to 4\gamma$ using the decay $K^\pm \to \pi^\pm\pi^0$ as a source of kinematically defined π^0's. No events were observed, where one event would correspond to a branching ratio $(\pi^0 \to 4\gamma)/(\pi^0 \to 2\gamma)$ of 2.7×10^{-5}. (auth)

19517 EXPERIMENTAL TEST OF QUANTUM ELECTRODYNAMICS FOR THE REACTION $e^+e^- \to \gamma\gamma$ AT 4 GeV CENTER-OF-MASS ENERGY. Hanson, G. (Massachusetts Inst. of Tech., Cambridge); Leong, J.; Newman, H.; Law, M. E.; Litke, A.; Madaras, R.; Wilson, R.; Hofmann, A.; Law, L.; Little, R.; Paterson, J. M.; Pordes, R.; Strauch, K.; Tarnopolsky, G. Lett. Nuovo Cim.; 7: No. 13, 587-591(28 Jul 1973).

The cross section for the reaction $e^+e^- \to \gamma\gamma$ was measured at a total energy of 4 GeV and production angle between 53° and 127°, both in the center-of-mass system. Details are given of the experimental set-up. A comparison with theoretical quantum electrodynamics predictions yielded $\sigma_{exp}/\sigma_{QED} = 1.05 \pm 0.22$. (LBS)

19518 SPIN-PARITY ANALYSIS OF ρ′ IN THE REACTION $\gamma p \to \pi^+\pi^+\pi^-\pi^-p$ AT 9 TO 18 GeV. Park, J. C. H. (Max-Planck Institut fuer Physik und Astrophysik, Munich). Nucl. Phys.; B58: No. 1, 45-54(1973).

A formalism concerning the four-pion decay of a resonance including identical particles is developed. A simple test based on this formalism when applied to new high-energy data on the reaction $\gamma p \to \rho' p \to \pi^+\pi^+\pi^-\pi^-p$ yields strong evidence that ρ′ is a vector meson (1^-), although in the data examined another possibility, $J^P = 2^+$, cannot be excluded. (auth)

19519 MEASUREMENT OF PROTON AND NEUTRON ELECTROMAGNETIC FORM FACTORS AT SQUARED FOUR-MOMENTUM TRANSFERS UP TO 3 $(GeV/c)^2$. Bartel, W.; Buesser, F. W.; Dix, W. R.; Felst, R.; Harms, D.; Krehbiel, H.; Kuhlmann, P. E.; McElroy, J.; Meyer, J.; Weber, G. (DESY, Hamburg). Nucl. Phys.; B58: No. 2, 429-475(1973).

Electron-proton elastic scattering cross sections were measured at squared four-momentum transfers q^2 of 0.67, 1.00, 1.17, 1.50, 1.75, 2.33 and 3.00 $(GeV/c)^2$ and electron scattering angles θ_e between 10° and 20° and at about 86° in the laboratory. The proton electromagnetic form factors G_E^p and G_M^p were determined. The results indicate that $G_E^p(q^2)$ decreases faster with increasing q^2 than $G_M^p(q^2)$. Quasi-elastic electron-deuteron cross sections were determined at values of q^2 = 0.39, 0.565, 0.78, 1.0 and 1.5 $(GeV/c)^2$ and scattering angles between 10° and 12°. At q^2 = 0.565 $(GeV/c)^2$ data were also taken with θ_e = 35° and at q^2 = 1.0 and 1.5 $(GeV/c)^2$ with θ_e = 86°. Electron-proton as well as electron-neutron scattering cross sections were deduced by the ratio method. The theoretical uncertainties of this procedure are shown to be small by comparison of the bound with the free proton cross sections. The magnetic form factor of the neutron G_M^n derived from the data is consistent with the scaling law. The charge form factor of the neutron is found to be small. (auth)

19520 POSITRON ANNIHILATION. Badoux, F. Diss. Nr. 4584. Zurich; Eidgenoessische Technische Hochschule (1971). 56p. (In German).

Thesis.

Electron-positron annihilation was studied on polycrystalline metals, covalent compounds, and fluid solutions. The positron sources used were ^{22}Na at room temperature, and ^{64}Cu at higher temperatures. Angular correlations measurements were performed within the range of one degree. The gamma photons were recorded with two CsI(Tl) scintillators. The study comprised α and β tin; the isoelectronic series α Sn, InSb, CdTe, β AgI; the α and β modifications of thallium; the temperature effects in Pb-Tl alloys, and the fluid Hg-In alloys. (HBG)

Weak

Refer also to abstract 19617.

19521 (RL-73-18, pp 90-109) HIGHLY INELASTIC NEUTRINO REACTIONS AT ACCELERATOR ENERGIES. Venus, W. A. (Rutherford High Energy Lab., Chilton, Eng.). 1973.

An account is given of the data at present available from the CERN bubble chamber experiments on the inclusive reactions: $\nu + N \rightarrow \mu^- +$ hadrons, and $\bar{\nu} + N \rightarrow \mu^+ +$ hadrons. The account falls under the following headings: general description of experiments, theoretical background, tests of scale invariance in previous experiments, the present neutrino experiments in Gargamelle, preliminary results, future developments. (UK)

19522 DETERMINATION OF THE ENERGY DEPENDENCE OF THE K^0_{e3} FORM FACTOR. Ashford, V. A. San Diego, CA; Univ. of California (1973). 99p. University Microfilms Order No. 73-16,361.

Thesis (Ph. D.).

The t dependence of the vector form factor, $f_+(t)$ was measured with a wire spark chamber spectrometer and gas Cerenkov counter. Assuming a linear parameterization, $f_+(t) = f_+(0)(1 + \lambda_+ t/m_\pi^2)$, $\lambda_+ = .028 \pm .009$ is found using a sample of 21,000 events. The error is primarily an estimate of systematic effects. (Diss. Abstr. Int., B)

19523 MEASUREMENT OF K_{13} FORM FACTORS IN $K^+_{\mu 3}$ DECAYS. Merlan, S. J. New Haven; Yale Univ. (1972). 81p. University Microfilms Order No. 73-14,598.

Thesis (Ph. D.).

Wire spark planes and scintillation counters were used in an experiment designed to measure the decay correlations among the products of the decay of stopped K^+ mesons to a muon, neutrino and pion, and to measure the polarization of the muon. The results determined the value of the form factor ratio to be $\xi(0) = -0.62 \pm 0.28$. The momentum dependence of the f_+ form factor was defined by the measured value of $\lambda_+ = 0.024 + 0.022$ (taking $\lambda_- = 0$). From the analysis of the muon polarization, taking the values for λ_+ and λ_- found for the decay correlation analysis, the form factor ratio was measured to be $\xi(0) = -0.64 \pm 0.27$. (Diss. Abstr. Int., B)

19524 MEASUREMENT OF K_{13} FORM FACTORS IN $K^0_{\mu 3}$ DECAYS. Sessoms, A. L. New Haven; Yale Univ. (1972). 83p. University Microfilms Order No. 73-16,392.

Thesis (Ph. D.).

Using a magnetic spectrometer, consisting of a wide gap magnet and proportional wire chambers, and a polarimeter, designed to measure the polarization of muons, the decay $K^0_L \rightarrow \pi + \mu^+ + \nu_\mu$ was studied. The muon polarization was measured as a function of the kinetic energy of the pion and of the muon in the K-meson rest system. The result, expressed in a conventional parametrization of the K-meson leptonic decay, indicates the ratio of the form factors to be $\xi(0) = -0.28 \pm 0.22 - 5\Lambda - 10\lambda_+$. Assuming $\lambda_- = 0$ and $\lambda_+ = 0.03$ one obtains $\xi(0) = -0.68 \pm 0.22$. (Diss. Abstr. Int., B)

Strong (Baryon-induced)

Refer also to abstract 19909.

19525 (COO-3065-44) PROTON-PROTON COLLISIONS AT 102 GeV/c. Slattery, P. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Apr 1973. Contract AT(11-1)-3065. 14p. (CONF-730320-3). Dep. NTIS $3.00.

From conference on high energy particle interactions; Nashville, Tennessee, USA (26 Mar 1973).

Preliminary results from an analysis of 102 GeV/c proton-proton collisions using the NAL 30 inch bubble chamber are discussed. Single particle inclusive spectra for the reactions $pp \rightarrow p + \ldots$ and $pp \rightarrow \pi^\pm + \ldots$ are presented, and comparisons are made with corresponding data from other high energy experiments carried out both using NAL and lower energy accelerators. (auth)

19526 (FRNC-TH-360) STUDY OF THE CHANNELS OF THE $\bar{p}d \rightarrow p_s\bar{p}p\pi^-$ and $\bar{p}d \rightarrow p_s\bar{p}p\pi^-\pi^0$ REACTIONS AT 5.5 GeV/c. Michalon, A. (Strasbourg Univ. (France)). 1972. 132p. (In French). Dep. NTIS (U. S. Sales Only) $8.75.

Thesis.

Both channels of the $\bar{p}d \rightarrow p_s\bar{p}p\pi^-$ and the $\bar{p}d \rightarrow p_s\bar{p}p\pi^-\pi^0$ reactions at 5.5 GeV/c were studied. The impulse approximation enabled experimental results to be obtained together with information on the $\bar{p}n$ reactions. It was assumed that the momentum of the spectator nucleons follows the Hulthen distribution. Estimates were made for the $\bar{p}n \rightarrow \bar{p}p\pi^-$ and $\bar{p}n \rightarrow \bar{p}p\pi^-\pi^0$ cross sections: 1.68 ± 0.11mb and 1.15 ± 0.10mb. Examinations of the effective mass spectra of the $\bar{p}n \rightarrow \bar{p}p\pi^-$ channel reveal the importance of the $\bar{\Delta}^{--}(1236)(51 \pm 4\%)$ resonance production. The production of the $\bar{\Delta}^{--}(1236)$p final state was envisaged in a Regge pole exchange model. A narrow peak occurs when $M = 3.05 \pm 0.1$ GeV/c² and another when $M = 0.02 \pm 0.01$ GeV/c². The distributions of events, which do not present resonances in the final state, were fitted using a double exchange Regge pole model. The $\bar{p}n \rightarrow \bar{p}\pi^-\pi^0$ channel is also dominated by $\bar{\Delta}^{--}(1236)$ production in spite of the fact that $\bar{\Delta}^-(1236)$ and $\Delta^+(1236)$ production are also observed. It seems that for the first time the decay of $\Delta(1640)$ by the $\bar{\Delta}^{--}(1236)\pi^0$ mode is observed. (auth)

19527 (LA-UR-73-894) SEARCH FOR A PARITY-VIOLATING CONTRIBUTION TO NUCLEON-NUCLEON SCATTERING. Nagle, D. E.; Hwang, C. F.; Jarmie, N.; Lovoi, P. A.; McKibben, J. L.; Mischke, R. E.; Ohlsen, G. G.; Potter, J. M.; Stevens, R. R. Jr.; Debrunner, P.; Fritts, D.; Frauenfelder, H.; Sorensen, L. (Los Alamos Scientific Lab., N. Mex.; Illinois Univ., Urbana). 1973. 11p. (CONF-730642-4). Dep. NTIS $3.00.

From fifth international conference on high-energy physics and nuclear structure; Uppsala, Sweden (18 Jun 1973).

One manifestation of the weak interaction between nucleons would be a parity-violating effect in nucleon-nucleon scattering. It is expected that such effects exist, at least at the level of 10^{-7} of the normal cross section, in low-energy pp and pd scattering. An experiment was undertaken at 15 MeV to detect a small dependence of the pp scattering cross section on the longitudinal polarization of the beam. Current efforts are concentrating on reducing systematic effects which at present restrict the sensitivity to the level of 2×10^{-4}. (auth)

19528 (LBL-2012) CHANGING $\Sigma(1660)$ BRANCHING RATIO. Eberhard, P. H. (California Univ., Berkeley. Lawrence Berkeley Lab.). May 1973. Contract W-7405-eng-48. 7p. (CONF-730448-2). Dep. NTIS $3.00.

From conference on baryon resonances; LaFayette, Indiana, USA (20 Apr 1973).

Three new experimental results were reported about the branching ratio $\Sigma\pi\pi/\Sigma\pi$ of the $\Sigma(1660)$ resonance produced in K^-p production experiments. One of them contradicts, and the two others corroborate statements published years ago, according to which this branching ratio changes with production angle. Overwhelming evidence is still in favor of the changing branching ratio, which can be simply explained by the existence of two $\Sigma(1660)$ with different branching ratios and different production distributions. (auth)

19529 (NP-19795) ANNUAL REPORT, 1972. (European Organization for Nuclear Research, Geneva (Switzerland)). 1972. 221p.

The report consists of sections on Laboratory I: Basic and ISR programs and Laboratory II: 300-GeV accelerator program. Nuclear physics, theoretical physics, data handling, machine operation, and administration are included. As is usual with reports in this series, some data are presented, but the nature of the document is basically descriptive. Among the appendixes is a 33-page list of CERN publications. (RWR)

19530 (ORO-4449-1) STUDY OF THE NEUTRON-PROTON INTERACTION IN THE 300 TO 700 MeV ENERGY REGION. Northcliffe, L. C. (Texas Agricultural and Mechanical Univ., College Station). 1973. Contract AT(40-1)-4449. 4p. Dep. NTIS $3.00.

Experimental equipment preparation for the study of the n + p interaction is described. (JFP)

19531 PARTICLE COMPOSITION AT HIGH TRANSVERSE MOMENTA IN p-p COLLISIONS IN THE CENTRAL REGION AT THE CERN ISR. CERN, Geneva Phys. Lett., B; 44B: No. 6, 527-529(11 Jun 1973).

Preliminary measurements were made at center of mass energies $\sqrt{s} = 31$ and 44 GeV of the π, K and p production ratios at 90° for p_T between 2.0 and 3.5 GeV/c. The $(K + p)/\pi$ ratio is given down to $p_T = 1.4$ GeV/c. No strong energy dependence is observed for these transverse momenta. (auth)

19532 EXPERIMENTAL TESTS OF LIMITING FRAGMENTATION AT THE ISR. Bellettini, G. (Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Braccini, P. L.; Bradaschia, C.; Castaldi, R.; Del Prete, T.; Foa, L.; Firomini, P.; Laurelli, P.; Menzione, A.; Valdata, M. Phys. Lett.; 45B: No. 1, 69-72(25 Jun 1973).

Direct tests of the hypothesis of limiting fragmentation from an experiment at the CERN Intersecting Storage Rings at centre-of-mass energies between 31 and 53 GeV are presented. Single-particle inclusive distributions and partial multiplicity distributions are observed for the case in which the energy of one beam is fixed while varying the energy of the other beam. Within cones around the beam, limiting fragmentation is shown to be valid. (auth)

19533 pp INTERACTIONS AT 303 GeV/c: PRODUCTION ANGLE DISTRIBUTION. Dao, F. T. (National Accelerator Lab., Batavia, IL); Gordon, D.; Lach, J.; Malamud, E.; Schivell, J.; Meyer, T.; Poster, R.; Schlein, P. E.; Slater, W. E. Phys. Lett.; 45B: No. 1, 73-76(25 Jun 1973).

The projected production angles of all charged particles in more than 1600 pp interactions at 303 GeV/c were measured. Semi-inclusive distributions of pseudo-rapidity and dispersion of pseudo-rapidity were obtained event-by-event. The mean dispersion is found to be approximately constant for charged multiplicity, n_{ch}, from 6 to 16. (auth)

19534 EVIDENCE FOR A STRONGLY INTERACTING PARTICLE OF MASS >40 GeV. Baruch, J. E. F.; Brooks, G.; Kellermann, E. W. (Univ. of Leeds, Eng.). J. Phys., A (London); 6: No. 7, L98-L103(Jul 1973).

The hadron energy spectrum recently published by Baruch, Brooke and Kellermann (Nat. Phys. Sci., 242: 6-7 (1973) and other spectra measured at sea level and at high altitudes under absorbers can be more easily understood if one assumes the existence of a new type of particle of mass >40 GeV. (auth)

19535 SEARCH FOR HEAVY QUASISTABLE LEPTONS. Bushnin, Yu. B.; Dunaytsev, A. F.; Golovkin, S. V.; Kubarovskii, V. P.; Landsberg, L. G.; Leont'ev, V. M.; Petrunina, T. I.; Senko, V. A.; Zaytsev, A. M. (Inst. for High Energy Physics, Serpukhov, USSR). Nucl. Phys.; B58: No. 2, 476-493(1973).

Negative results of a search for heavy quasistable charged leptons at the IHEP accelerator are reported. For the selection of heavy leptons a system of scintillation and gas Čerenkov counters was used. The upper limit estimations of the differential cross sections for heavy lepton production in pN collisions at E_p = 70 GeV are, for example, $d^2\sigma/dpd\Omega$ (p = 30 GeV/c, θ = 2 mrad, $1 \leq M_\lambda \leq 4.8$ GeV) = 4.10^{-38} cm^2/sr $\cdot$GeV. The results of the present work, together with the data on muon pair production in nucleon-nucleon interactions, show that there are no heavy charged leptons with masses from 0.55 GeV ($\tau_\lambda > 7 \cdot 10^{-10}$ sec) up to 4.5 GeV ($\tau_\lambda > 3 \cdot 10^{-8}$ sec). (auth)

19536 POSSIBLE POLARIZATION MEASUREMENT FOR $\bar{p}p \rightarrow \bar{K}K$, $\pi^+\pi^-$ REACTION. Peaslee, D. C. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3069. Aust. J. Phys.; 26: No. 2, 265-267(Apr 1973).

Polarization measurements are suggested for nucleon–antinucleon annihilation into two pseudoscalar mesons in the S region (total energy ~1.9 to 2.0 GeV). The particular purpose is to distinguish the dominant J value of suspected ^{3}D resonances; measurements with both beams and targets polarized would be especially revealing. (auth)

Strong (Meson-induced)

Refer also to abstract 18368.

19537 (CEA-N-1602) STUDY OF π^-p INTERACTIONS FROM 500 TO 765 MeV/c AND PARTIAL WAVE ANALYSIS OF THE $\pi^-p \rightarrow \pi^-p\pi^0$ AND $\pi^-p \rightarrow \pi^-\pi^+n$ REACTIONS. Nguyen, T. D. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1973. 158p. (In French). Dep. NTIS (U. S. Sales Only) $10.00.

Thesis. Submitted to Paris Univ. (France).

The formation of the resonances S_{11} (1535 MeV), P_{11} (1470 MeV) and D_{13} (1520 MeV) was studied in the reactions $\pi^-p \rightarrow \pi^-p\pi^0$ and $\pi^-p \rightarrow \pi^-\pi^+n$ using the generalized isobar model with $\pi\Delta$, $N\rho$ and $N\sigma$ as intermediate states. The 271000 pictures taken in the 180-litre Saclay hydrogen bubble chamber at four incident momenta: 530, 620, 690 and 765 MeV/c were analyzed. The solutions obtained provided a coherent description of all open channels, i.e. πN, $\pi\pi N$ and ηN, and allowed one to calculate the decay branching ratios of each partial wave into the channels $\pi\Delta$, $N\rho$, $N\sigma$, $N\eta$. (auth)

19538 (CEA-N-1611) STUDY OF 0^- $1/2^+$ FINAL STATES PRODUCED BY K$^-$–PROTON SCATTERING AT 3.95 GeV/c. Moscoso, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1973. 120p. (In French). Dep. NTIS (U. S. Sales Only) $8.00.

Thesis. Submitted to Paris Univ., Orsay (France).

Some K$^-$p interactions at 3.95 GeV/c were studied in the CERN 2 m HBC. Results are presented for final states with $J^P = 0^-$ $1/2^+$: $\bar{K}^0n$, $\pi^0\Lambda$, $\eta\Lambda$, $\pi^-\Sigma^+$, $\pi^+\Sigma^-$. Peripheral and anti-peripheral peaks in the angular distributions, as well as the main features of the hyperon polarization, are analyzed using meson and baryon exchange models. Data for $\pi^-\Sigma^+$ and $\pi^0\Lambda$ production in the t-channel are compared to those for the line-reversed π-proton reactions at the same beam momentum. Results for Λ and Σ produced by the same incident meson agree with SU(6)W symmetry, the quark model, and the vector meson dominance model. The backward cross sections for $\Lambda\pi$ and $\Sigma\pi$ final states are compared to the elastic and charge exchange backward π-proton scattering data obtained at 4 GeV/c. (auth)

19539 (KFKI-73-17) PRODUCTION OF γ QUANTA IN π^--N INTERACTIONS AT 40 GeV/c. Bucharest-Budapest-Krakow-Dubna-Hanoi-Serpukhov-Sofia-Tashkent-Tbilisi-Ulan-Bator Warsaw Collaboration. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). May 1973. 27p. Dep. NTIS (U. S. Sales Only) $3.50.

Data on the average multiplicity of neutral pions are presented for π^-p, π^-n and π^-C interactions at 40 GeV/c, based on the statistics of 9432 γ-quanta. A significant increase was found in the average number of π^0-s per inelastic event as a function of the number of charged particles for these interactions. Average momenta and angular characteristics of the γ-quanta are presented in both the lab and the c.m. systems. It can be concluded that there is a plateau ($\ln -1 \leq y^* \leq 1$ interval) in $(1/\sigma_{in})(d\sigma/dy^*) = f(y^*)$ distribution of γ-quanta for π^-p interaction and the value of the π^-p cross section at $y^* = 0$ quite well agrees with the pp cross section at p = 500 to 1500 GeV/c. This is in favor of the scaling hypothesis in the central region $y^* = 0$ for 40 GeV/c π^-p interaction. (auth)

19540 (LBL-2067) MEASUREMENT OF THE K$^-\pi^-$ ELASTIC CROSS SECTION AND STUDY OF THE K$^-\pi^+\pi^-$ MASS SPECTRUM IN THE REACTION $K^-p \rightarrow K^-p\pi^+\pi^-$ AT 2.7 GeV/c. Kirschbaum, A. R. (California Univ., Berkeley. Lawrence Berkeley Lab.). Apr 1973. Contract W-7405-eng-48. 52p. Dep. NTIS $4.75.

Thesis.

A pole-extrapolation measurement of the K$^-\pi^-$ elastic scattering cross section for two intervals in K$^-\pi^-$ invariant mass from threshold to 0.84 GeV is presented. These measurements were obtained from the reaction $K^-p \rightarrow K^-\pi^-\Delta^{++}(1238)$ at 2.05 and 2.63 GeV/c. It is shown how the effect of the background from the competing one-pion-exchange process $K^-p \rightarrow (K^-\pi^+)(\pi^-p)$ can be approximately accounted for, and it is found that the extrapolated cross sections are relatively insensitive to the presence of this background. In addition, using only the 2.63 GeV/c data, the enhancements which occur in the K$^-\pi^+\pi^-$ invariant mass in the Q region including a description of their t-dependence are studied. The one-pion-exchange model is again used to account for the background behavior under these enhancements. (auth)

19541 (NP-19810) ANALYSIS OF THE REACTION $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ AT 25 AND 40 GeV/c. Klanner, R. (Munich Univ. (West Germany)). 1973. 118p. Dep. NTIS (U. S. Sales Only) $8.00.

Thesis.

A counter experiment is described which measured the reaction $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ at beam momenta of 25 and 40 GeV/c. The experiment was performed at the 76-GeV/c proton synchrotron at Serpukhov, USSR. The events of the reaction $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ were measured by spark chambers, scintillation counters and an analyzing magnet, and identified by kinematic reconstruction. Production and decay of the 3π system were investigated by the partial wave decomposition of the 3π system. The following results were found: The 3π system A1 and A2, known from experiments at lower beam energies, are strongly produced at high energies. Whereas the A2 system can be described by a Breit–Wigner amplitude, this is not true for the A1 system. The results of this experiment are compared with the findings of other experiments. (auth)

19542 (ORO-2504-192) K$^+$p ELASTIC SCATTERING BETWEEN 0.865 AND 2.125 GeV/c. Goldman, J. H. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Dec 1972. 187p. Dep. NTIS $11.50.

Thesis.

The K$^+$p elastic differential cross sections were measured with high statistics at twenty-two momenta between 0.865 and 2.125 GeV/c in the center of mass angular region of about $.9 > \cos\theta > -.9$. The data are to be used as input to an energy-independent phase shift analysis of the elastic channel. It is hoped that the phase shift analysis will resolve the question of whether or not there is a Z_1^{++} resonance in this energy interval. The experiment was performed in a two stage, enriched kaon beam at Argonne National Laboratory. The equipment included a liquid hydrogen target, magnetostrictive read out wire spark chambers to detect the scattered particles, and an on-line computer. The actual data analysis was done completely off-line. The data are summarized in terms of Legendre polynomial expansion coefficients and compared with other experiments. (auth)

19543 (UCR-34-P-107-B-146) PARTIAL WAVE ANALYSIS OF $\pi^+p \rightarrow \pi^0\Delta^{++}$ AT 1820 TO 2090 MeV. Mehtani, U.; Fund, S. Y.; Kernan, A.; Schalk, T. L.; Williamson, Y.; Birge, R. W.; Kalmus,

G. E.; Michael, W. (California Univ., Riverside; California Univ., Berkeley. Lawrence Radiation Lab.). 1972. 15p. (CONF-720923-15). Dep. NTIS $3.00.

From 16th international conference on high energy physics; Chicago, Illinois, USA (6 Sep 1972).

Partial wave analysis of $\pi^+p \rightarrow \pi^0\Delta^{++}$ at 1820 to 2090 MeV c.m. energy shows that this reaction is dominated by the F_{37} (1950) resonance with $\sqrt{\chi_{\pi N}\chi_{\pi\Delta}} = 0.44 \pm 0.5$. The analysis also gives evidence for F_{35} (1890) $\rightarrow \pi\Delta$ via F-wave with $\sqrt{\chi_{\pi N}\chi_{\pi\Delta}} = 0.20 \pm 0.04$. (auth)

19544 STRANGE PARTICLE AND π^- MESON PRODUCTION IN 12.7 GeV/c K^+p INTERACTIONS. Stone, S. L. Rochester, NY, Univ. of Rochester (1973). 183p. University Microfilms Order No. 73-14,838.

Thesis (Ph. D.).

The analysis of data involving the production of Λ° and Ξ^- hyperons, $\bar{\Lambda}^\circ$ $\bar{\Xi}^+$ antihyperons, and K^0 and π^- mesons in 12.7 K^+p interactions is discussed. The 80-inch BNL hydrogen bubble chamber served as both a source of target proton and as a detector of charged particle tracks. Interactions occurring inside the bubble chamber were recorded on film; approximately 160,000 triads were taken during the course of this experiment. In addition, a previous 80-inch BNL hydrogen bubble chamber experiment, involving π^+p collisions at 7 GeV/c was reanalyzed in order to provide a sample of produced π^- mesons. It was found that the K^0, Λ^0 and $\bar{\Xi}^+$ particles appear to be fragments of the incident K^+ meson and that Λ^0 and Ξ^- hyperons appear to be produced as a result of the fragmentation of the target proton. In fact, when low multiplicity final states are examined such as Λ^0 K^+ K^+ and V^0pp it is found that these final states appear to be produced through a diffraction-like process. The π^- meson distributions, on the other hand, in both 12.7 GeV/c K^+p and 7 GeV/c π^+p collisions contain large contributions from both beam and target fragmentation. Specifically, the center of mass longitudinal momentum distributions at these π^- mesons exhibit an asymmetry similar to that observed, for example, in single pion production in 25 GeV/c π^-p interactions. This asymmetry is discussed in terms of the quark structure of hadrons and other dynamical models. Also the π^- mesons in both the beam fragmentation and target fragmentation regions are compared to pions produced in 28.5-GeV/c pp interactions (Brookhaven data) and pions produced in 24.8-GeV/c π^-p interactions (Wisconsin data). It is observed that the distributions for negative pions which have low laboratory momentum (target fragments) in π^+p, K^+p and pp interactions agree with each other when normalized by their respective asymptotic total cross sections; in contrast the corresponding distribution from the π^-p reaction is significantly different from the rest. This behavior was conjectured on theoretical grounds, predictions of these theoretical models are compared with data. (Diss. Abstr. Int., B)

19545 STUDY OF THE REACTION $\pi^+ + p \rightarrow \rho^+ + p$ AT INCIDENT MOMENTA 1.28 TO 1.84 GeV/c. Williamson, Y. S. Riverside, CA; Univ. of California (1972). 108p. University Microfilms Order No. 73-15,648.

Thesis (Ph. D.).

The experimental results of a high statistics hydrogen bubble chamber study of the reaction $\pi^+ + p \rightarrow \rho^+ + p$ at seven values of incident pion momentum in the range 1.28 to 1.84 GeV/c are presented. The principal features of the data are: The differential cross section, $d\sigma/dt$, is only a slowly varying function of the c.m. energy. At each momentum it has the strong forward peak and the dip at $-t \simeq 0.5$ GeV^2 which characterize this reaction at energies above the resonance region. There is a strong dip at $-t \simeq 0.4$ GeV^2 in both ρ^*_{00} and ρ^*_{00} $d\sigma/dt$. This dip has not been previously reported. It is predicted by the "strong cut reggeized absorption" model (SCRAM), for absorbed pion exchange. SCRAM also predicts a zero in Re ρ^*_{10} at $-t \simeq 0.4$ GeV^2 associated with π exchange. In the momentum range 1.55 to 1.84 GeV/c, it is found that Re ρ^*_{10} passes through zero at $-t \sim 0.35$ to 0.55 GeV^2. The quantity $(\rho_{11} + \rho_{1-1})$ $d\sigma/dt$ has a pronounced dip at $-t \simeq 0.5$ GeV^2. This dip is observed at higher energies, and it is predicted for the ω exchange contribution to the cross section in either a conventional Regge pole model with nonsense wrong signature zeroes or in a strong absorption model. In summary, the data show several structures which appear to be at fixed t. The nature of these structures suggests that the reaction $\pi^+p \rightarrow \rho^+p$ is dominated by π and ω exchange in the t-channel. The pronounced dip in ρ^*_{00} $d\sigma/dt$ and the zero in Re ρ^*_{10} further suggest that the π exchange is strongly absorbed. It is interesting that the dominance of t-channel exchanges found in the reaction $\pi^+ + p \rightarrow \rho^+ + p$ at higher energies persists all the way down to threshold. (Diss. Abstr. Int., B)

19546 STUDY OF INCLUSIVE π^- PRODUCTION IN π^+d INTERACTIONS AT 24 GeV/c. Sreedhar, V. A. Baltimore; Johns Hopkins Univ. (1973). 162p. University Microfilms Order No. 73-16,663.

Thesis (Ph. D.).

A study of inclusive π^- production in π^+d interactions at 24 GeV/c beam momentum is reported. The data are obtained from the Brookhaven 80'' bubble chamber exposed to an rf separated π^+ beam from the Alternating Gradient Synchrotron. About 16,000 tracks from about 12,000 pictures are used in the analysis giving a statistical sensitivity of 3.2 μb/event. There is an average charge multiplicity $\langle n_{ch} \rangle = 6.7 + 0.2$ and $\langle n_{ch}\,(n_{ch}-1) \rangle = 30 + 1$ per inelastic collision. The invariant distributions in p_l (projectile), fractionality x and rapidity y are presented along with the investigation of correlations among π^-. The results are compared with those from π^+p experiments in an attempt to investigate the characteristics of π^+n inclusive interaction. An agreement is found with other π^+p experiments for distributions of p_l in projectile and lab frames, but a disagreement in the negative regions of fractionality and rapidity plots. (Diss. Abstr. Int., B)

19547 ELASTIC SCATTERING OF K^+ MESONS FROM A POLARIZED PROTON TARGET. Glodis, P. F. New Haven; Yale Univ. (1973). 197p. University Microfilms Order No. 73-16,779.

Thesis (Ph. D.).

Using a lanthanum magnesium nitrate polarized target, the polarization parameter and differential cross section in K^+p elastic scattering was measured for incident kaon momenta between 1.3 and 2.6 GeV/c. The results of this experiment represent a significant addition to the total data in the K^+p elastic channel. This is especially true above 1.9 GeV/c where the data fill an obvious gap in polarization measurements. The experiment has several advantages with respect to previous polarized target measurements. The most significant advance is the use of a high resolution wire spark chamber system to measure the outgoing angles of both particles. The polarization data were included in a new phase shift analysis of the K^+p channel using the accelerated convergence method of Cutkosky and Deo. No indications of exotic resonances was found. (Diss. Abstr. Int., B)

19548 STUDY OF THE INCLUSIVE REACTIONS $\pi^-p \rightarrow \Lambda^0 +$ ANYTHING AND $\pi^-p \rightarrow K^0_S +$ ANYTHING AT 11.2 GeV/c OF INCIDENT MOMENTUM. Borzatta, P. (Univ., Milan); Liotta, L.; Tallone Lombardi, L.; Ratti, S.; Goussu, O.; Vincent, M. A. Lett. Nuovo Cim.; 7: No. 14, 641-648(4 Aug 1973).

Total cross sections and distributions are given for inclusive spectra of Λ^0 and K^0_S produced in π^- + p interactions at 11.2 GeV/c in a hydrogen bubble chamber. (JFP)

19549 πp ELASTIC SCATTERING FROM 88 TO 292 MeV. Bussey, P. J. (Univ. of Glasgow); Carter, J. R.; Dance, D. R.; Bugg, D. V.; Carter, A. A.; Smith, A. M. Nucl. Phys.; B58: No. 2, 363-377(1973).

Differential cross sections for π^+p and π^-p elastic scattering were measured with an accuracy of typically ±2% at 10 and 9 energies respectively in the range 88 to 292 MeV of lab kinetic energy. (auth)

19550 EXPERIMENTAL TESTS OF THE FACTORISATION OF REGGE TRAJECTORIES IN THE PROTON FRAGMENTATION REGION. Athens-Democritus-Liverpool-Vienna Collaboration Nucl. Phys.; B58: No. 2, 420-428(1973).

Double differential cross sections are presented for the reactions $K^- + p \rightarrow \pi^\pm +$ anything at 8.25 GeV/c. Using published data for reactions $K^+ + p \rightarrow \pi^- +$ anything and $p + p \rightarrow \pi^+$ anything the differential cross sections for $\gamma + p \rightarrow \pi^- +$ anything, $\pi^- + p \rightarrow \pi^- +$ anything and $\pi^- + p \rightarrow \pi^+ +$ anything in the target fragmentation region are predicted based on factorisation of the pomeron and Regge trajectories. The predictions agree with the experimental data and support the hypothesis of factorisation of the Regge trajectories in the target fragmentation region. (auth)

19551 CROSS SECTIONS OF COMMON FINAL STATES FOR K^-p INTERACTIONS AT 8.25 GeV/c. Athens-Democritus Liverpool-Vienna Collaboration Nucl. Phys.; B58: No. 2, 408-419(1973).

Topological and channel cross sections are given for the more common final states produced in K^-p interactions at 8.25 GeV/c together with the single particle inclusive cross sections. Cross sections are presented for prominent resonances occurring in final states $\bar{K}N(n\pi)$ and the resonance fractions are to be roughly independent of multiplicity. (auth)

19552 πp PHASE SHIFTS FROM 88 TO 310 MeV. Carter, J. R. (Cavendish Lab., Cambridge, Eng.); Bugg, D. V.; Carter, A. A. Nucl. Phys.; B58: No. 2, 378-396(1973).

Phase shift solutions are presented at pion kinetic energies from 88 to 292 MeV where new measurements of the differential elastic cross section are available, and at 310 MeV. The resulting phase shifts are fitted to effective-range formulae. The resonant P_{33} phase shift is allowed to take different values for π^+p and π^-p scattering. There are differences in mass and width between these charge states of the resonance of $M^0 - M^{++} = 1.4 \pm 0.4$ MeV/c^2 and $\Gamma^0 - \Gamma^{++} = 10.3 \pm 1.3$ MeV/c^2. The difference in width can be accounted for largely but not entirely by the Coulomb barrier, the channel $\pi^-p \rightarrow \gamma n$, and the difference in phase space between $\pi^-p \rightarrow \pi^0 n$ and $\pi^+p \rightarrow \pi^+p$. (auth)

19553 TWO-PRONG FITTED CHANNELS AT 11.7 GeV/c. Evans, D. (Univ. of Durham, Eng.); Neat, K.; Caso, C.; Trevisan, U.; Antich, P.; Cecchet, G.; Ratti, S.; Daronian, P.; Daudin, A.; Lewin, C. Nuovo Cim.; 16A: No. 2, 299-314(21 Jul 1973).

A sample of 43,000 two-prong events obtained at a momentum of 11.7 GeV/c is used to determine the cross sections of the fitted channels, and to study the reaction $\pi^+p \rightarrow \pi^+p\pi^0$. In particular the quasi-two-body channels $\pi^0\Delta^{++}$ and ρ^+p are investigated. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 19529.

19554 (ORO-3992-131) BOOTSTRAP EQUATIONS FOR FIREBALL DECAY. Chiu, C. B.; Gleiser, R. J. (Texas Univ., Austin. Center for Particle Theory). Jun 1973. Contract AT (40-1)-3992. 34p. (CPT-180). Dep. NTIS $3.75.

Various bootstrap equations are studied which describe successive decay of fireballs. These equations are generalizations of the original statistical bootstrap equation of Hagedorn and of Frautschi. In particular, the average pion multiplicity is investigated as a function of the fireball mass for various kernels, and the constraint due to the conservation of energy on the correlation parameter $f_2 = \langle n\,(n-1)\rangle - \langle n\rangle^2$. This latter constraint tends to give rise to a negative f_2. Also the pion energy distribution is derived for a constant kernel model. An exponential fall off in this distribution is found in the small energy region. Lastly, a bootstrap equation which includes both the π and the ρ as the ground states is represented. A possible connection between this model and the slope of the $\langle n_0\rangle_-$ vs n_- data is given. (auth)

19555 ANOMALOUS SINGULARITIES IN INCLUSIVE CROSS SECTIONS AND THE NATURE OF REGGE SINGULARITIES. Patrascioiu, Adrian (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 7: No. 10, 3010-3014 (15 May 1973).

The analytic properties of the 1-particle inclusive cross sections are used to prove the presence of anomalous singularities in the asymptotic expression of the 3-to-3 amplitude in the single-Regge limit. The nature of the Regge singularities associated with such anomalous singularities is investigated. (auth)

19556 COUPLED DIRAC EQUATIONS. Taylor, F. C. Jr. Chapel Hill, NC; Univ. of North Carolina (1972). 81p. University Microfilms Order No. 73-16,523.

Thesis (Ph. D.).

It is shown that a formalism proposed by E. P. Wigner in 1969 for treating interacting particles using a Diraclike equation is not self-consistent. (Diss. Abstr. Int., B)

19557 POSSIBLE TYPES OF EQUATIONS FOR ZERO-MASS PARTICLES. Fushchich, V. I.; Nikitin, A. G. (Inst. of Mathematics, Kiev). Lett. Nuovo Cim.; 7: No. 11, 439-442(14 Jul 1973).

It is shown that if a particle (and antiparticle) of zero mass is characterized by helicity and by the sign of energy only (without additional quantum numbers) three and only three types of two-component Poincare-invariant essentially different (in respect to C, P, T properties) equations exist. (LBS)

19558 INTERACTIONS OF ELEMENTARY PARTICLES IN DUAL PARTON MODEL. Miyatake, Y. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 1, 316-321(Jan 1973).

The origins of interactions of elementary particles are analyzed with the string model of Nambu and Susskind. Strong, electromagnetic and weak interactions originate from the different partons in the hadrons. Partons in the center of the string have nothing to do with weak interactions. (auth)

19559 MODEL OF RELATIVISTIC QUANTUM MECHANICS OF INTERACTING PARTICLES. Kita, H. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 6, 2422-2444(Dec 1972).

A new model of relativistic quantum mechanics of interacting particles with form factors is obtained. The model is similar to the old one proposed previously by the author but is different from the old one in that this time the state vectors $|q^{(1)}, \ldots, q^{(n)}\rangle^{(\pm)}$ obey the simple transformation law. It is pointed out that the perfect parallelism between the P_4 and the M_{4l} in their forms is essential for the transformation properties of these state vectors. (auth)

19560 UNITARITY BOUND ON THE EVOLUTION OF NONSTATIONARY STATES. Fleming, G. N. (Pennsylvania State Univ., University Park). Nuovo Cim.; 16A: No. 2, 232-240 (21 Jul 1973).

A version of an equation derived by Ersak is studied to obtain rigorous bounds on the rate of change of the integrity of a normalized state. (auth)

19561 URBARYON REARRANGEMENT AND THE BREAKING OF LINE REVERSAL RELATIONS. I. Matsuoka, T.; Sawada, S. (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 49: No. 2, 562-572(Feb 1973).

From the standpoint of urbaryon rearrangement, the breaking of line reversal relations is examined for the s-channel helicity flip and nonflip amplitudes for meson-baryon scattering, respectively. It is shown that in the s-channel helicity flip amplitude the breaking converges near $P_L = 5$ GeV/c (incident laboratory momentum), whereas it does not in the nonflip amplitudes up to $P_L \sim 20$ GeV/c. It becomes evident that this situation is shared in common by both strangeness nonexchange and exchange processes. A discussion of the relation between the breaking of line reversal relations and the composite structure of hadrons is also presented. (auth)

19562 GOLDBERGER-TREIMAN RELATION IN THE RENORMALIZED SIGMA MODEL. Strubbe, H. Ghent; Ghent Rijksuniversiteit (1972). 110p. (In Dutch).

Thesis.

It is well known that the Goldberger-Treiman relation (G.T.) implies $d(0)K(0) = g_A m/f_\pi/G_{\pi NN} = 0.9$, where $d(q^2)$ and $K(q^2)$ are respectively the pion propagator form factor and the proper πNN vertex form factor. Such deviation from unity is looked upon as the effect of a small breaking of chiral symmetry. This breaking is supposed to be also responsible for the nonvanishing mass of the pion. The intention is to study the correlation between d(0)K(0) and the pion mass, μ_π. A symmetric regularization is applied which does not break the symmetry. By this is meant that, even for finite regulator masses, the Ward identities are satisfied. When taking those masses to infinity, the renormalization scheme is easily seen. Moreover, the G.T. relation is explicitly verified to hold in terms of the renormalized quantities. An alternative renormalization technique was introduced by Symanzik. It was applied to the sigma model by Bessis and Turchetti, who calculated their diagrams by means of a dispersion relational method. The subtraction constants are interrelated by Ward identity constraints. The numerical calculation of the G.T. relation is considered. The conclusion is, however, that the renormalized model cannot quantitatively describe reality. Whatever pion mass is used, d(0)K(0) will never reach the value 0.9. Finally, a computation was made in the sense of "continuous symmetry breaking." (auth)

19563 RATIOS OF THE MASSES OF CERTAIN ELEMENTARY PARTICLES. Dixon, G. (Rutgers-The State Univ., New Brunswick, NJ). Particles Nucl.; 5: No. 1, 23-28(Jan 1973).

It is proposed that the ratios of the masses of certain of the elementary particles are rational numbers. This implies a system in which the masses in question can be represented by integers. These integers are here analyzed, and it is hoped this analysis will convince one that the closeness with which this integral system approximates reality is more than coincidence. (auth)

Electromagnetic

Refer also to abstracts 19123, 19550, and 19715.

19564 (DESY-73/14) RENORMALIZATION AND DEEP INELASTIC LEPTON-NUCLEON SCATTERING. Gutbrod, F.; Schroeder, U. E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1973. 40p. Dep. NTIS (U. S. Sales Only) $4.00.

A model for deep inelastic electroproduction, where the photon does not couple to pointlike constituents, but to physical particles with form factors is investigated. Scaling behavior for the structure functions is obtained by a compensation between form factor effects and increasing integrals over a propagator spectral function and over a function similar to that corresponding to the vertex diagram. A sufficient condition for scaling is the generalized scaling behavior of a hadronic four point function such that it is more singular than in perturbation theory. In contrast to the standard parton model, the average transverse momenta of final state particles should increase without limit as $-q^2 \to \infty$. (auth)

19565 (IC-72/14) MESON PHOTOPRODUCTION IN THE STATISTICAL APPROACH TO DUAL HADRODYNAMICS: APPLICATION TO ρ^0 PHOTOPRODUCTION. Hacinliyan, A.; Maheshwari, A. (International Centre for Theoretical Physics, Trieste (Italy)). Mar 1972. 27p. INIS.

The application of the dual theory of hadron electromagnetic currents to meson photoproduction is studied. The "statistical approximation" of Chang, Freund and Nambu to the dual resonance model is used for calculating the Born approximation Feynman graphs. A technique for constructing gauge-invariant amplitudes in the limit of statistical approximation to the dual amplitudes is developed. It is found that the vector-meson photoproduction amplitude in this model has similar properties to those of the vector-meson dominance model based on the photon vector analogy. The model developed is applied to data of the process $\gamma p \to \rho^0 p$. The fit to ρ photoproduction differential cross section allows one to estimate the charge distribution weight function of the dual hadrodynamics. (auth)

19566 (ITEF-919) APPLICATION OF CORRELATION VALUES WHEN SIMULATING THREE QUANTUM RADIATIVE DECAYS. Guter, R. S.; Muratova, T. A. (Gosudarstvennyi Komitet po Ispol'Zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'Noi Fiziki). 1972. 12p. (In Russian). INIS.

The possible application of schemes of negatively correlated values for model simulation of three-quanta radiative decays was examined. (tr-auth)

19567 (RL-73-18) PROCEEDINGS OF AN INFORMAL MEETING ON LINKS BETWEEN WEAK AND ELECTROMAGNETIC INTERACTIONS, RUTHERFORD HIGH ENERGY LABORATORY, 24-25 FEBRUARY 1973. Toner, W. T.; Zia, R. K. P. (eds.) (Rutherford High Energy Lab., Chilton (England)). 1973. 178p. (CONF-730216-). Dep. NTIS (U. S. Sales Only) $11.00.

Separate abstracts are prepared for the 9 papers included. (LBS)

For abstracts of individual papers see: 19123, 19521, 19568-19572, 19619, and 19620.

19568 (RL-73-18, pp 42-54) LEPTON PRODUCTION AT THE ISR. Duff, B. G. (University Coll., London). 1973.

It is stated that present interest is in the production of leptons, in p-p collisions, which arise from electromagnetic and weak processes. The following possibilities are considered: lepton pair production by electromagnetic processes, heavy lepton production, weak interaction processes, real intermediate vector boson (W) production. The discussion is under headings: cross section estimates; what cross sections are observable at the ISR? Current experiments at the ISR, (1) search for electrons and electron pairs (CERN-Columbia-Rockefeller), (2) search for muons and muon pairs (British Collaboration). (UK)

19569 (RL-73-18, pp 55-89) WHAT HAVE WE LEARNED FROM ELECTRON SCATTERING? Close, F. E. (Daresbury Nuclear Physics Lab., Eng.). 1973.

The subject is discussed under the following headings: kinematics for inclusive electroproduction; elastic scattering and the Q^2 behavior at fixed W^2; neutrino data and its relation to electron data; does everything scale in ω_W?; g-2 for partons? (UK)

19570 (RL-73-18, pp 110-133) QUARKS AND DEEP INELASTIC PROCESSES. Landshoff, P. V. (Cambridge Univ., Eng.). 1973.

It is stated that the assumption that nucleons in some sense consist of quarks provides the most successful model so far available for correlating the data for the following deep inelastic processes: (a) $eN \to eX$, (b) νN or $\bar{\nu}N \to \mu X$, (c) $e^+e^- \to X$, (d) $NN \to \mu^+\mu^- X$, (e) $NN \to \pi X$. In each case X denotes a system of hadrons. Three apparently different languages can be used to formulate the theory: (i) Feynman's parton approach, (ii) covariant field theory softened at large momentum (or short distance), (iii) light cone algebra. The subject is considered under the following heads: electroproduction, neutrino experiments, muon-pair production, mesons at large transverse momentum, electron-positron annihilation, $\pi^0 \to 2\gamma$, the final state in electroproduction and annihilation. (UK)

19571 (RL-73-18, pp 160-164) ELECTRON-NEUTRON COLLIDING BEAM EXPERIMENTS. Gabathuler, E. (Daresbury Nuclear Physics Lab., Eng.). 1973.

It is stated that the possibility of doing experiments with colliding electron-proton beams to obtain very high values of S, the square of the total centre-of-mass energy, has aroused much interest. It is pointed out that storage rings can, in principle, store deuterons as well as protons, and the spectator nucleon then provides a very simple method of tagging the electron-proton or electron-neutron reaction. A list is given of experiments under way or planned to study lepton-nucleon interactions. The possibilities are examined under the following heads: total photon cross sections, structure functions, weak interactions. (UK)

19572 (RL-73-18, pp 166-176) EPIC WAYS OF STUDYING WEAK BOSONS. Budny, R. (Oxford Univ.). 1973.

The feasibility is examined of studying weak interactions with possible future electron-positron storage rings such as EPIC II with beam energies of 14 GeV and luminosity 10^{32}. Weak boson effects are considered in the reactions $e^+e^- \to \mu^+\mu^-$ and $e^+e^- \to \nu\bar{\nu}$ within the framework of Weinberg's (Phys. Rev. Letters; 19: 1264 (1967)) unified theory of weak and electromagnetic interactions. (UK)

19573 (SLA-73-5548) TIME-DEPENDENT MULTICHANNEL COULOMB SCATTERING THEORY. Chandler, C.; Gibson, A. G. (New Mexico Univ., Albuquerque). 1973. 18p. Dep. NTIS $3.00. For Sandia Labs., Albuquerque, NM.

The formulation by Mulherin and Zinnes of two-particle Coulomb scattering theory is extended to the multichannel case. The wave operators so obtained are proved by a direct method to be identical with those of Dollard. (auth)

19574 CURRENT ALGEBRA AND ANGULAR DISTRIBUTION OF π^+ MESONS IN REACTION $ep \to en\pi^+$. Kulish, Yu. V. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 18: No. 4, 611-614(Apr 1973). (In Russian).

Within the framework of the current algebra the processes of the π^+-mesons electroproduction on protons near the resonance $N^*(1236)$ are considered. The cross sections at $k^2 = 1$ GeV^2 are calculated at different values of the axial form factor. The transversal cross section is the most sensible to the axial form factor at $\Theta \approx \pi$ (Θ is an angle between the nucleon momenta in sci of πN-system). (auth)

19575 LIGHT-CONE VS NON-LIGHT-CONE CONTRIBUTIONS TO STRUCTURE FUNCTIONS IN THE BJORKEN LIMIT. Bhaumik, D.; Greenberg, O. W. (Center for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. D 7: No. 10, 3136-3141 (15 May 1973).

The Bjorken limit [$\nu \to \infty$, $Q^2 \to \infty$, with $\hat{x} = \mathcal{Q} - \nu$ fixed, $\mathcal{Q} = (\nu^2 + Q^2)^{1/2}$] of structure functions $W(\hat{x},\mathcal{Q}) = \int d^4x\, e^{iqx}\langle p|[j(x),j(0)]|p\rangle$ is considered for matrix elements with x-space singularities of the form $\langle p|[j(x),j(0)]|p\rangle = \epsilon(x^0)\delta^{(k)}(x^2 - a^2)f(r)$, $k = 0,1,2,\ldots$, for $a^2 > 0$ and $a^2 = 0$, as point functions and as distrubutions. The momenta p and q are the scalar "nucleon" and virtual-photon four-momenta, respectively; $Q^2 = -q^2 > 0$, $M\nu = p\cdot q$, M is the "nucleon" mass, and $r = |\vec{x}|$ in the nucleon rest frame. For $a^2 > 0$, the structure function is bounded as a point function by $C\mathcal{Q}^{-\frac{1}{2}n/2+k/2}$, $\mathcal{Q}$ large, if $r^n f(r) \notin L^2(0,\infty)$; for $a^2 = 0$ it is bounded by $C\mathcal{Q}^{k-1}$, independent of n. Considered as a distribution, the structure function is bounded by $C_j\mathcal{Q}^{-j}$ for all j for $a^2 > 0$; for $a^2 = 0$ the point-function bounds remain relevant. (auth)

19576 NUMERICAL SOLUTIONS TO TWO-BODY PROBLEMS IN CLASSICAL ELECTRODYNAMICS: STRAIGHT-LINE MOTION WITH RETARDED FIELDS AND NO RADIATION REACTION. Huschilt, J.; Baylis, W. E.; Leiter, D.; Szamosi, G. (Physics Department, University of Windsor, Windsor, Ontario, Canada N9B 3P4). Phys. Rev. D 7: No. 10, 2844-2850 (15 May 1973).

Trajectories of two charged particles of equal mass have been calculated for straight-line motion using retarded fields without radiation reaction. Both attractive and repulsive interactions are considered. For the attractive case, in which particles are released from rest with various initial separations d, the acceleration is shown to approach $-\sqrt{2}$ (in natural units) as the particles approach each other, and oscillations which are significant for $d \lesssim 1$ are strongly damped for $d \gg 1$. For the repulsive case, in which the particles are thrown directly at one another with high initial velocity, no lower limit is found for the distance of closest approach as initial velocities are increased. Furthermore, the particle energy is found to increase during collision. We explain this result in terms of an energy-conservation theorem and

discuss its significance with regard to the omission of radiation reaction. (auth)

19577 ASYMPTOTIC OPERATORS FOR COULOMB SCATTERING. Schweber, S. S. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). Phys. Rev. D 7: No. 10, 3114-3115 (15 May 1973).

The connection between Zwanziger's prescription for asymptotic fields for charged particles and the Dollard–Kulish–Fadeev formalism is pointed out. (auth)

19578 UPPER BOUNDS ON THE VALUES OF MASSES IN UNIFIED GAUGE THEORIES. Dicus, Duane A.; Mathur, Vishnu S. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 7: No. 10, 3111-3114 (15 May 1973).

Upper bounds are found for the masses of most of the new, unobserved, particles in unified gauge theories by requiring that the partial-wave amplitudes satisfy unitarity bounds. (auth)

19579 PARTIALLY CONSERVED AXIAL-VECTOR CURRENT AND CHIRAL ANOMALIES. Chanowitz, Micheal S.; Chen, Min-Shih; Li, Ling-Fong (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 7: No. 10, 3104-3110 (15 May 1973).

We discuss means of testing the validity of the weak and strong partially conserved axial-vector current hypotheses when applied to the theory of chiral anomalies. A factorization property (abstracted from a model due to Drell) is proposed and applied to $\eta \to \gamma\gamma$, $\eta \to \pi\pi\gamma$, $\gamma \to \pi\pi\pi$, and $\gamma\gamma \to \pi\pi\pi$. (auth)

19580 COMMENT ON THE PARTIALLY CONSERVED AXIAL-VECTOR CURRENT SUM RULE FOR THE ANOMALOUS VERTEX FUNCTIONS. Terazawa, Hidezumi (The Rockefeller University, New York, New York 10021). Phys. Rev. D 7: No. 10, 3123-3126 (15 May 1973).

We investigate the sum rule relating the anomalous vertex function (as a function of virtual-photon squared masses q^2 and k^2) of $\pi^0\gamma\gamma$ to the form factors of the axial-vector-vector-vector (AVV) vertex derived from the hypothesis of partial conservation of axial-vector current including the Bell-Jackiw-Adler anomaly and from the algebra of currents. One of the consequences is that, if the $\pi^0\gamma\gamma$ vertex function decreases at all, a certain combination of the form factors of the AVV vertex should decrease as fast as $(q^2+k^2)^{-1}$ when one of q^2 and k^2 increases. An experimental check of the sum rule is suggested. (auth)

19581 COMMENT ON WEAK AND ELECTROMAGNETIC MASS DIFFERENCES. Yang, T. C. (Department of Physics, University of California, La Jolla, California 92037). Phys. Rev. D 7: No. 10, 3130-3135 (15 May 1973).

We discuss weak and electromagnetic mass differences of pions in the framework of (I) current algebra, and (II) a renormalizable Lagrangian model. (auth)

19582 HEAVY PION, MODIFIED PARTIALLY CONSERVED AXIAL-VECTOR CURRENT HYPOTHESIS, AND π^0–2γ: CLASSIFICATION OF NEW MODELS, INCLUDING GAUGE MODELS. Bars, I.; Halpern, M. B. (Department of Physics, University of California, Berkeley, California 94720). Phys. Rev. D 7: No. 10, 3043-3049 (15 May 1973).

The gauge model of hadrons strongly suggests a heavy pion. Motivated by this, we classify and discuss general chiral-like models, including a heavy pion. Workable models are discussed with respect to a number of popular theoretical ideas. Particular attention is paid to such topics as $\pi^0 \to 2\gamma$, the anomaly-free partially conserved axial-vector current relations of the gauge model, and Lagrangian realization of Drell's recent dispersion model. (auth)

19583 ELECTROMAGNETIC RADIUS OF THE NEUTRINO. Landovitz, L. F. (Belfer Graduate School of Science, Yeshiva University, New York, New York 10033); Schreiber, W. Phys. Rev. D 7: No. 10, 3014-3017 (15 May 1973).

The electromagnetic radius of the neutrino is investigated in the intermediate-boson theories of Haller, Landovitz, and Goldberg (HLG) and of Lee and Wick. In the Lee and Wick theory, the radius depends on the ratio of the vector-boson mass to that of the scalar-boson mass. For the case where they are equal, the radius is approximately the same as that of the HLG theory. (auth)

19584 DISPERSION CALCULATION OF THE ANOMALOUS MAGNETIC MOMENT OF THE ELECTRON. McEnnan, James (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15213). Phys. Rev. D 7: No. 10, 2961-2966 (15 May 1973).

Using a self-consistent electron–positron elastic scattering amplitude developed previously, we present a cutoff-independent dispersion calculation of the two-body-intermediate-state correction to the electron magnetic moment. The complete second-order (in α, the fine-structure constant) contribution to the anomalous part of the magnetic moment, $\kappa = (1/2)(g-2)$, due to two-body exchange is $\kappa^{(2)}-\kappa^{(1)} = (-0.940)\,\alpha^2/\pi^2$. The coefficient of the second-order term has the proper sign but is considerably larger than the experimental value (–0.328). The large difference between our result and the correct value indicates that many-body effects may be as important as two-body exchange in dispersion calculations for electrodynamics. We conclude that the published cutoff dispersion-theoretic estimates of the higher-order corrections to the electron magnetic moment based only on a consideration of the two-body intermediate state are not likely to be correct. (auth)

19585 JOST-LEHMANN-DYSON REPRESENTATION AND SCALING. Baragar, F. A.; Kamal, A. N. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev. D 7: No. 10, 3025-3031 (15 May 1973).

Scaling of the imaginary part of the forward scattering amplitude for scalar-photon-scalar-nucleon scattering is shown to be consistent with the Jost-Lehmann-Dyson (JLD) representation. The first nonleading term in the expansion in inverse powers of ν is retained to demonstrate the scale-breaking effect. The coordinate-space treatment is shown to be equivalent to the JLD approach to order ν^{-1}. (auth)

19586 NEUTRINO ELECTROMAGNETIC RADIUS. Landovitz, L. F. (Yeshiva Univ., New York); Schreiber, W. Particles Nucl.; 5: No. 2-3, 66-68(1973).

The electromagnetic radius of the neutrino is calculated using quantum field theory methods, assuming the nonexistence of the weak interaction W-boson. The result obtained is in agreement with a previous investigation using dispersion relation techniques. Additional terms are included, leading to a significantly different muon-type neutrino radius. (auth)

19587 EXPERIMENTAL COMPARISON OF THE VELOCITY OF 10 GeV GAMMA RAYS TO THE VELOCITY OF VISIBLE LIGHT. Brown, B. C. San Diego, CA; Univ. of California (1973). 222p. University Microfilms Order No. 73-13,629.

Thesis (Ph. D.).

An experiment carried out at the Stanford Linear Accelerator Center to compare the velocities of propagation of visible (eV) and high energy (GeV) electromagnetic radiation is reported. Previous experiments are reviewed. The apparatus and data are described. The result obtained gives a relative velocity difference $[c(\text{GeV}) - c(\text{eV})]/c(\text{eV}) = (1.2 \pm 6) \times 10^{-6}$. Also the velocity V_e of 11 GeV electrons is compared to the velocity of optical light with a result $1 - \beta_e = (c(\text{eV}) - V_e)/c(\text{eV}) = (-1.3 \pm 2.7) \times 10^{-6}$. (Diss. Abstr. Int., B)

19588 DIFFRACTION MODEL FOR HADRON PRODUCTION. Wu, C. C. New Haven; Yale Univ. (1972). 152p. University Microfilms Order No. 73-16,413.

Thesis (Ph. D.).

A diffraction model for particle production, the nova model, as proposed by Jacob and Slansky is extensively discussed. The model stresses the mechanism that either (or both) of the two initial particles is (are) quasi-elastically excited to a superposition of resonance states, a nova, which decays into secondary particles with an isotropic decay distribution in the nova rest frame. As a function of the nova mass M, the cross section for producing a nova rises to a low mass maximum and falls off like M^{-2}. In this picture, there exists a simple connection between the transverse-momentum distribution, the longitudinal-momentum distribution and the average multiplicity of the secondaries. The scaling behavior of the inclusive distribution is obtained as a result of the diffractive nature of the nova production and the emphasis on the low-mass novas. The variety of shapes of the single-particle spectra is a simple kinematic effect in this model. Detailed model calculations are in good agreement with the experimental data in πp and pp collisions. In addition, some predictions of the model on the two-particle distributions are discussed. Good agreement with data further confirms the understanding of the production processes. By making use of the assumption of vector dominance, the model is applied to obtain the meson distributions in photo production. The excellent agreement of this result with the data strongly supports both the vector dominance and the nova model. (Diss. Abstr. Int., B)

19589 POSSIBILITY OF CONSTRUCTING A PHOTON WITH TWO NEUTRINOS. Moles, M. (Univ., Paris). Compt. Rend., Ser. A, B; 276: No. 11, 397-400(12 Mar 1973). (In French).

Several research workers have recently put forward a new neutrinic theory of light. The possibility of constructing a non-zero mass photon (conforming with the Broglie and Schroedinger hypotheses) with two nonzero mass neutrinos is examined following the proposition suggested by Cabbibo to explain the Davis experi-

ments on solar neutrinos. The feasibility of this possibility is demonstrated. (auth)

19590 FIELD OF CHARGED PARTICLE MOVING ALONG THE AXIS OF A CHANNEL IN A LAMINAR MEDIUM. Mergelyan, O. S. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 7: No. 5, 324-328 (1972). (In Russian).

The radiation of a charge moving along the axis of a channel is considered. The dielectric permeability of surrounding medium is a periodic function along the axis of the channel. The diffraction radiation is generated in the channel and outside it,—the Vavilov-Cherenkov radiation diffracted on the inhomogeneities, as well as the transition-like radiation in a laminar medium. (auth)

19591 RADIATION FROM CHARGED PARTICLE MOVING IN A DIELECTRIC ALONG THE PLANE BOUNDARY WITH PERIODICALLY CHANGING ITS DENSITY DIELECTRIC MEDIUM. Mergelyan, O. S. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 7: No. 5, 329-339(1972). (In Russian).

In the perturbation theory approximation the problem of the radiation of charge-in-flight in isotropic dielectric medium above plane boundary with the medium-dielectric properties of which periodically depend on three coordinates is considered. The expressions for the energy losses both in isotropic and periodically inhomogeneous media are obtained. The surface wave generation is discussed as well. (auth)

19592 EMPIRICAL OBSERVATION OF THE ENERGY DEPENDENCE OF VARIOUS PARTICLE CROSS SECTIONS. Martin, F. (Stanford Univ., CA). Nucl. Phys.; B58: No. 1, 301-314(1973).

The energy dependence of total cross sections and total elastic cross sections has been examined for protons, antiprotons, kaons, pions and photons. This dependence is very well expressed in terms of the cm velocity $\beta = 2P^*/\sqrt{s}$. Some comments are made on the relationship to Regge theory. (auth)

19593 QUASI-INDEPENDENT QUARK MODEL AND HADRON ELECTROMAGNETIC FORM FACTORS AT LARGE TRANSFERRED MOMENTA. Dushenko, V. F.; Kobushkin, A. P. (Inst. for Theoretical Physics, Kiev). Lett. Nuovo Cim.; 7: No. 13, 529-532(28 Jul 1973).

The asymptotic behavior of electromagnetic hadron form factors in the quasi-independent quark model is discussed and is shown to be of the dipole type. (LBS)

19594 π^+/π^- ASYMMETRY IN INCLUSIVE ELECTROPRODUCTION OF HADRONS. Cleymans, J. (Technische Hochschule, Aachen). Nuovo Cim.; 16A: No. 3, 445-448(1 Aug 1973).

Mueller's Regge analysis, combined with the so-called generalized scaling laws of the parton model, predicts an increase in the π^+/π^- asymmetry in the photon fragmentation region for increasing Q^2 when all other relevant variables are kept fixed. (auth)

19595 DUALITY AND ELECTRON-POSITRON ANNIHILATION AT HIGH ENERGY. Chaichian, M. (Univ., Bielefeld, Ger.); Satz, H.; Kitakado, S. Nuovo Cim.; 16A: No. 3, 437-444 (1 Aug 1973).

General constraints of duality are applied to annihilation processes $e^-e^+ \to h$ + anything, where h stands for meson or baryon octets. All planar dual terms, as well as a possible background contribution are considered. The interrelation of duality and dominance of specific terms is investigated. (auth)

19596 PHOTOPRODUCTION PROCESSES $\gamma N \to \pi N, \eta N, K\Lambda, K\Sigma$ IN A DUAL MODEL WITH FIXED POLES. Bender, I. (Univ., Heidelberg); Koerner, J. G.; Schmidt, M. G.; Linke, V. Nuovo Cim.; 16A: No. 3, 377-410(1 Aug 1973).

The photoproduction of pseudoscalar mesons is investigated in the framework of a dual B_β-model with fixed and Regge poles. A reasonable fit to the available high-energy forward scattering data is presented which is characterized by essentially three parameters. The values of the Regge residues for natural- and unnatural-parity exchanges agree with the values obtained in other photoproduction models. The photoexcitation features of the low-lying baryon resonances derived from our model are in qualitative agreement with experimental results. (auth)

19597 DUALITY, THE QUARK-PARTON MODEL AND INCLUSIVE PION ELECTROPRODUCTION. Pallua, S.; Zarmi, Y. (CERN, Geneva). Lett. Nuovo Cim.; 7: No. 11, 455-459(14 Jul 1973).

The consequences of duality for the process $\gamma_v + N \to \pi + X$ in the current fragmentation region are studied within the framework of the quark-parton model. New relations among the structure functions in single pion distributions are obtained. It is shown that duality ideas impose strong constraints on single hadron distributions in the current fragmentation region. (LBS)

19598 CLASSICAL INTERACTIONS BETWEEN CHARGED PARTICLES: AN ORDERING PROCEDURE. Lo Surdo, C. (EURATOM-CNEN, Frascati, Italy). Nuovo Cim.; 16B: No. 1, 139-161(11 Jul 1973).

A systematic ordering procedure in powers of the inverse light velocity, simultaneously applied to the Maxwell and dynamical equations, is used to calculate the trajectories of two or more charged particles moving under the influence of their own electromagnetic fields. Since the procedure is mainly of methodological interest, the discussion is limited to the basic case of non-confined fields with normal conditions at infinity. The ordering is also examined in detail when applied to the fundamental conservation theorems. (auth)

19599 INCLUSIVE REACTION $e^+e^- \to$ RESONANCE + ANYTHING. Renard, F. M. (Dept. de Physique Mathematique, Montpellier, France). Lett. Nuovo Cim.; 7: No. 14, 654-658 (4 Aug 1973).

The inclusive spectrum and structure functions for meson resonance production in $e^+ + e^-$ inclusive interactions are discussed for low and high energies. (JFP)

19600 PROTON STRUCTURE AND THE QUASI-POTENTIAL DESCRIPTION OF THE PROTON-ELECTRON INTERACTION. II. Desimirov, G. M. (International Centre for Theoretical Physics, Trieste, Italy); Petkova, N. P. Lett. Nuovo Cim.; 7: No. 14, 638-40(4 Aug 1973).

The proton-electron interaction and the influence of proton structure described by a suitable form factor are considered. Formulas are given which can be used for calculating relativistic corrections for the energy levels of hydrogen and for describing scattering processes. (JFP)

19601 POSSIBLE TESTS OF SCALE INVARIANCE IN VERY HIGH ENERGY e^+e^- COLLISIONS. Ferrara, S.; Grillo, A. F.; Parisi, G. (CNEN, Frascati, Italy. Phys. Lett.; 45B: No. 1, 63-65(25 Jun 1973).

The differential cross section for the process $e^+e^- \to e^+e^-$ X is connected to properties of the asymptotic zero mass theory. Assuming Wilson's expansion relations between different measurable quantities are obtained. (auth)

19602 COMMENTS ON AN ELECTROPRODUCTION SUM RULE. Genova, J. (State Univ. of New York, Stony Brook). Lett. Nuovo Cim.; 7: No. 14, 615-620(4 Aug 1973).

A sum rule for spin-averaged electroproduction structure functions previously derived from the DGS representation, causality, scaling, and Regge behavior is examined with a more physical example from perturbation theory. The perturbation theory result is examined for spin-1 photons and ϕ^3 interacting spinless particles. The example is used to examine the questions of causality and the DGS representation. It is shown that the reason Brandt's sum rule fails for this example is a technical error uncovered previously. (JFP)

19603 PHOTON REST MASS AND INTERGALACTIC MAGNETIC FIELDS. Burman, R. R.; Byrne, J. C. (Univ. of Western Australia, Nedlands). J. Phys., A (London); 6: No. 7, L104-L107(Jul 1973).

Conditions for the existence and stability of the currents which would be required to support an intergalactic magnetic field are examined to see what upper limit could be obtained for the photon rest mass if the existence of such a field is established. (auth)

19604 DOES $\rho'(1650)$ CONTRIBUTE TO THE NUCLEON FORM FACTOR. Billandi Filho, J.; Meyer, R. F. (Deutsches Elektronen-Synchrotron, Hamburg). Lett. Nuovo Cim.; 17: No. 12, 477-481(21 Jul 1973).

It is shown that essential contributions to the nucleon form factor do not only come from the ρ, but also from the higher-mass region. It is shown from an analysis of strong vector-meson-nucleon coupling constants and different form factor fits that the $\rho'(1650)$ is a good candidate. (LBS)

19605 ROLE OF TWO-PHOTON INCLUSIVE HADRON PRODUCTION IN HIGH-ENERGY e^+e^- COLLISIONS. Gatto, R.; Preparata, G. (Univ., Rome). Lett. Nuovo Cim.; 17: No. 12, 507-517(21 Jul 1973).

The total two-photon cross sections in e^+e^- colliding beams were studied in the equivalent-photon approximation by distinguishing two regions in the integration over the two-photon cm squared energy Si resonance region, $s < 4$ (GeV)^2, and diffractive region $s > 4$ (GeV)^2. It is concluded that even at very high energy the two-photon processes are not expected to induce a large background for a reasonable cut-off in the transverse momentum at the emitted particle. (LBS)

19606 SOME REMARKS ABOUT THE USEFULNESS OF BEAM POLARIZATION IN e^+e^- STORAGE RINGS. Schilling, K. (Univ., Bielefeld, Ger.). Nuovo Cim.; 16A: No. 2, 217-231 (21 Jul 1973).

e^+e^- annihilation into hadrons is studied and it is shown to what extent, in the simplest experimental situations, beam polarization might be useful to measure electromagnetic structure functions in the one-photon approximation to this process. (auth)

19607 SUM RULES FOR KHURI AMPLITUDES AND LIGHT-CONE WILSON EXPANSION. Boiti, M.; Immirzi, G.; Maiella, G.; Pempinelli, F. (Univ., Lecce, Italy). Nuovo Cim.; 16A: No. 2, 345-375(21 Jul 1973).

The convolution theorem is used to obtain general sum rules for the Khuri amplitudes of the current correlation function (familiar from current algebra). The sum rules can be continued analytically in the Khuri λ-plane to negative integer values of λ; at these points the sum rules relate the finite-energy integral to the Fourier transform of distributions that, by the Gel'fand-Shilov method of analytic continuation, can be defined in a natural way as the current commutator and its derivatives on the light-cone. Assuming that the current commutator involved has a light-cone Wilson expansion, the previously mentioned sum rules can be written in terms of scaling amplitudes. Finally the peculiar features of the sum rules obtained in the case of conserved currents are considered. (auth)

19608 GRAVITATIONAL AND ELECTROMAGNETIC SHOCK WAVES. Lichnerowicz, A. Compt. Rend., Ser. A, B; 276: No. 20, 1385-1389(14 May 1973). (In French).

Gravitational and electromagnetic shock waves were studied using the distribution technique. The creation of gravitational shock waves by electromagnetic shock waves was also studied. (auth)

19609 CHARGE ASYMMETRY IN DECAYS OF THE SYSTEM $K^0\bar{K}^0$ PRODUCED VIA π^0 RESONANCE. Baier, V. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 17: No. 8, 320-323(20 Apr 1973).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 17: No. 8, 446-449(20 Apr 1973).

An analysis is made of the charge asymmetry produced when one of the kaons (or both) in the $K^0\bar{K}^0$ system produced in the reaction $e^+e^- \to \phi^0 \to K^0\bar{K}^0$ decays in the channel. K_{13}. (LBS)

19610 SPECTRUM OF PHOTONS EMITTED AT LARGE ANGLES IN e^+e^- COLLISIONS AT HIGH ENERGIES. Fadin, V. S.; Khoze, V. A. (Inst. of Nuclear Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 17: No. 8, 313-316(20 Apr 1973).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 17: No. 8, 438-441(20 Apr 1973).

The possibility of investigating weak interactions by measuring the process $e^+e^- \to \nu\bar{\nu}\gamma$ at large photon emission angles is considered. It is noted that background processes need to be examined in detail. Angular distributions and cross sections for the process $e^+e^- \to \nu\bar{\nu}\gamma$ as well as background processes are examined. The possibility of reducing the background from the process $e^+e^- \to e^+e^-e^+e^-\gamma$ when $e^+e^- \to e^+e^-\gamma$ is registered by choosing a certain value above the photon-detection threshold is shown. A few remarks are made concerning the angular distributions of the photons connected with the processes of hadron production in e^+e^- collisions. (LBS)

19611 WHAT MODEL OF HADRONS DOES THE LEPTON–HADRON COLLISION REQUIRE? Kahuto, A.; Senju, H. (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 49: No. 3, 957-974 (Mar 1973).

The present deep inelastic electroproduction data are analyzed from a rather general standpoint of the parton model, and it is investigated what model of hadrons is required by the data, referring to the related problems. In the data by the SLAC-MIT group, the important quantities νW_2^p, $\nu W_2^n/\nu W_2^p$ and the behavior of $\nu W_2^p - \nu W_2^n$ for large ω are not yet definite. Hence one makes the most reasonable assumptions about these quantities. The result is that the deep inelastic electroproduction data strongly suggest that an urbaryon is a many-body system (perhaps three-body system) of more fundamental particles with fractional charge. (auth)

19612 ELECTROPRODUCTION AND PARTON CHAINS IN THE NUCLEON. Krolikowski, W. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 21: No. 4, 363-369(1973).

A simple parton model of the nucleon where partons are correlated in such a way as if they formed chains of quarks (and antiquarks) linked by gluons is compared with SLAC-MIT electroproduction data. A nice fit to electroproduction data is obtained. (auth)

19613 EFFECT OF THE ELECTRON BEAM FRONT ON COHERENT CHERENKOV RADIATION. Pellat, R. (Ecole Polytechnique, Paris); Singh, R. P.; Lavergnat, J. Compt. Rend., Ser. D; 276: No. 16, 685-687(16 Apr 1973). (In French).

Coherent emission from an electron beam depends on the form of the beam front. The theoretical results obtained are applied to an experimental case. (auth)

19614 X-RAY TRANSITION RADIATION IN VARIOUS MATERIALS. Ispiryan, K. A.; Kankanyan, S. A.; Oganesyan, A. G.; Tamanyan, A. G. (Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 7: No. 5, 377-379(1972). (In Russian).

The spectral distribution of the transition radiation of 2.4 to 3.5 GeV electrons in the radiators of LiH, laminar medium of mylar foils and styrofoam is investigated. It is shown that in the photon energy region $\hbar\omega \sim 5$ to 10 keV the transition radiation yield from LiH radiator is higher than in other radiators under investigation. (auth)

19615 MICROWAVE INTERACTIONS WITH LOW ENERGY ELECTRONS. Hand, J. W. (Univ. of Newcastle upon Tyne, Eng.). J. Phys., A (London); 6: No. 7, 974-979(Jul 1973).

The equations of motion for a low energy electron interacting with a microwave electric field at the electron cyclotron frequency in a homogeneous magnetic field are solved numerically to determine the electron energy as a function of time and microwave electric field strength. The shape of the microwave power absorption signal is calculated for two ideal cases and for more practical cases in which both the interaction time and the mean time between collisions must be considered. (auth)

19616 FREE ELECTRON LASER. Madey, J. M. J.; Schwettman, H. A.; Fairbank, W. M. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 980-983 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

A brief review of the theory of stimulated bremsstrahlung by relativistic electrons in a periodic magnetic field is given, along with a discussion of the possibilities for a classical interpretation and a description of the apparatus under construction in W. W. Hansen Laboratories of Physics. (3 figures) (auth)

Weak

Refer also to abstracts 19521 and 19832.

19617 (COO-1428-323) ANNUAL REPORT, TASK C, FOR OCTOBER 1, 1972–SEPTEMBER 30, 1973. Fowler, E. C. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 1973. Contract AT(11-1)-1428. 102p. Dep. NTIS $7.25.

Running at SLAC on the experiment to search for exotic bosons in $\pi^+ + p$ interactions at 8.4 GeV/c was completed. A study of the $\nu_e + {}^{37}Cl \to {}^{37}Ar + e^-$ produced by ν_e from μ^+ decay at rest is proposed for LASL. A small working-type conference on baryon resonances was organized. The idea that leptons are quarks is studied, and a search for a second muon neutrino is proposed. (RWR)

19618 (ORO-3992-118) STUDY OF THE K_{13} FORM FACTORS BY THE ON-MASS-SHELL CURRENT ALGEBRA. Golestaneh, A. A. (Texas Univ., Austin. Center for Particle Theory). Feb 1973. Contract AT(40-1)-3992. 42p. (CPT-173). Dep. NTIS $4.25.

The hadron part of the vector amplitude of the K_{13} decay is evaluated directly from the reduction formalism and the J current algebra (JCA) with the on-mass-shell mesons. The octet current J is given as $c(\partial^2 + m^2)\phi = \partial_\mu J^\mu$ where m and c are the mass and decay constant of the pseudoscalar field ϕ, in the SU(3) × SU(3) scheme. The amplitude contains the commutators of the operators J_μ, ϕ, and the strangeness changing vector current V_μ. In evaluating it the intermediate states are saturated with the π, κ, K*, and A_1 meson single-particle states and with the two-meson states (κ, K) and (K*, K). The matrix elements are expressed in terms of form factors which are evaluated using the reduction formalism and dispersion relations with pole dominance. From these the form factors $f_\pm(t)$ of the K_{13} decay are determined, t being the K-π momentum transfer. Also an alternative computation of the $f_\pm$ is made by the tree-graph approximation, (T) method, using the theory of primary interactions with κ and K* as the dominant intermediate states in this decay. The results are analyzed in terms of the κ meson mass m_κ, width Γ_κ, and decay constant c_κ. The quantity $\xi(0) \equiv f_-(0)/f_+(0)$ is found as given by the JCA method depends sensitively on the κ data, and on the deviation of $f_+(0)$ from unity. For instance, one gets $\xi(0) = -0.75$, with $f_+(0) = 0.8$, if m_κ = 1.1 GeV, $c_\kappa = 0.35\ m_\pi$, and Γ_κ = 410 MeV; but $\xi(0) = -0.1$ with $f_+(0) = 0.98$, if one takes $m_\kappa = 0.98$ GeV, $c_\kappa = 0.4\ m_\pi$, and Γ_κ = 425

MeV. The $\xi(0)$ given by the T method is not sensitive to these parameters. It is interesting that the results of both methods lie within $\xi(0) = -0.56 \pm 0.02$ and $f_+(0) = 0.92 \pm 0.08$, for a range of combinations of the κ data within the narrow limits $m_\kappa = 1.04 \pm 0.06$ GeV, $c_\kappa = (0.35 \pm 0.05)m_\pi$, and $\Gamma_\kappa = 320 \pm 90$ MeV. (auth)

19619 (RL-73-18, pp 1-32) INTRODUCTION TO RENORMALIZABLE THEORIES OF WEAK INTERACTIONS AND THEIR EXPERIMENTAL CONSEQUENCES. Smith, C. H. L. (CERN, Geneva). 1973.

Notes are presented under headings, as follows: problems with the phenomenological theory of weak interactions (the Lagrangian, introducing a vector meson–W); motivation for elements of renormalizable models (need to introduce neutral currents and/or heavy leptons, unifying weak and electromagnetic interactions); an example—the Georgi–Glashow model, cancellation of leading divergences in the general case, gauge invariance, generalized gauge invariance; motivation for the "spontaneous mass generating mechanism" (example—the Georgi–Glashow model; an example of spontaneous mass generation); problems with models (quarks, Cabibbo current, current algebra, light cone); experimental consequences (1) W's must exist (Mw ~ 50 GeV?); (2) neutral currents; (3) heavy leptons; (4) scalar mesons ϕ; (5) charmed particles and/or failures of Cabibbo theory etc. (UK)

19620 (RL-73-18, pp 33-41) SEARCH FOR WEAK NEUTRAL CURRENT PROCESSES AT CERN USING GARGAMELLE. Cundy, D. C. 1973.

It is stated that since the start of the neutrino experiments at CERN in 1963, systematic searches have been carried out for weak neutral current processes. With the introduction of Gargamelle an order of magnitude gain in sensitivity has been obtained for some processes. This for example is the case for the process $\nu_\mu + e^- \rightarrow \nu_\mu + e^-$ which was looked for previously to set a limit on the magnetic moment, and now is so interesting with relationship to unified theories of weak interactions. Recent progress at CERN is described under two headings: search for $\nu_\mu(\bar{\nu}_\mu) + e^- \rightarrow \nu_\mu(\bar{\nu}_\mu) + e^-$; and search for hadronic neutral currents. Conclusions are drawn about the directions of future work. (UK)

19621 HIGHER-ORDER WEAK PROCESSES WITHOUT QUADRATIC DIVERGENCES. Holstein, Barry R.; Swift, Arthur R. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). Phys. Rev. D 7: No. 10, 3031-3042 (15 May 1973).

If the interaction kernel is energy-independent, the Bethe-Salpeter equation can be transformed to a version wherein the kernel is replaced by the zero-energy scattering amplitude. This transformed equation is then used in order to unitarize lepton-lepton scattering processes. Quadratic divergences are eliminated in this approach. All lepton-lepton scattering amplitudes and other higher-order weak phenomena, e.g., the neutrino charge radius, can be described in terms of a single unknown parameter. (auth)

19622 RENORMALIZATION OF GAUGE THEORIES, W DECAY AND μ DECAY. Appelquist, T. W.; Primack, J. R.; Quinn, H. R. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 7: No. 10, 2998-3009 (15 May 1973).

We present a renormalization program for spontaneously broken gauge theories in the unitary formalism. It is compared with the renormalization program for renormalizable gauges and necessary constraints are discussed. We then explicitly formulate this program for the Weinberg SU(2) $\times$U(1) theory of leptons and show how it provides the basis for the dispersive calculations of higher-order corrections to μ decay reported in a previous paper. As we pointed out there, certain symmetry-breaking effects are finite and calculable. In this paper, we calculate the breaking of μ–e universality in order α. We also explicitly verify the consistency of our renormalization procedure on the one-loop level. There are certain subtleties in the treatment of infrared divergences in gauge models, particularly in dispersive calculations. We give a method for handling this problem, calculate the rate for W decay, and complete the calculation of the photonic contributions to μ decay in the Weinberg SU(2) $\times$U(1) model. Our predictions for the decay rate and the electron energy spectrum in μ decay for the Weinberg model are experimentally indistinguishable from those of the old current-current theory of weak interactions. Finally we make some comments about other gauge models and other physical processes. (auth)

19623 LIGHT-CONE COMMUTATORS AND CHIRAL-SYMMETRY EFFECTS IN DEEP-INELASTIC PROCESSES. Feinberg, Frank L. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 7: No. 10, 3059-3076 (15 May 1973).

From the canonical light-cone commutators in the quark-vector-gluon model, the two most singular terms in the light-cone expansion for commutators of arbitrary Dirac bilinear covariants (local and bilocal) are derived and various interesting commutators are given explicitly. This operator expansion is then applied to deep-inelastic lepton-nucleon scattering, and the parity-violating as well as chiral-symmetry-breaking deep-inelastic structure functions are determined as the Fourier transforms of the diagonal matrix elements of the appropriate bilocal operators. A sum rule is derived which distinguishes between the parton model and the quark-vector-gluon model. In the vector-gluon model with a light-cone quantization, we consider a light-cone σ term for pion-nucleon scattering which differs from the usual σ term. (auth)

19624 MUON PAIR PRODUCTION BY NEUTRINOS AND THE STRUCTURE OF WEAK INTERACTIONS. Poon, C. H. San Diego, CA; Univ. of California (1973). 216p. University Microfilms Order No. 73-13,628.

Thesis (Ph. D.).

The kinematics of processes involving N spinless particles, in terms of invariant variables, are studied by means of Gram determinants. It is proposed that the Gram determinant method may provide a convenient unified treatment for general kinematical purposes. Using this approach, one first obtains the necessary and sufficient conditions for describing the physical regions; their solutions produce a systematic, practical scheme for constructing the physical regions explicitly. Secondly, a simple way of obtaining relations between geometrical and invariant quantities is described; some such relations are exhibited. The application of the Gram-determinant method is illustrated mainly with a discussion on the Toller angle dependence of the reggeon-reggeon-particle vertex function; in particular, a certain form of such dependence, in the asymptotic Regge limit, that arises naturally from the internal consistency of multi-Reggeism is found. Finally, the phase-space factor for many-particle productions is discussed. The production of $\nu_\mu \mu^-\mu^+$ and $\nu_e \mu^-\mu^+$ from ν_μ and ν_e beams, respectively, in a Coulomb field, is the simplest process which one may hope to observe involving the diagonal interaction of muons and mu-neutrinos. The kinematic distributions of the produced charged leptons may provide information on the structure of the effective weak interaction for these particles. With numerical calculations, the coherent production of these processes is examined with respect to (I) c(V + γA) interactions, for a typical set of values of c and γ, and (II) (S + P $\pm$ T) interactions. The first set is the most general form of interaction involving left-handed neutrinos, and the second set is related to the question of the existence of right-handed neutrinos. In case (I), the total cross sections are given by $|c|^2\,[\sigma_V + |\gamma|^2\,(\sigma_{V-A} - \sigma_V)]$. If time-reversal invariance is assumed, and if experimental kinematic cuts are symmetric in the charged leptons, then the value of γ can be obtained from a measurement of the energy asymmetry between the charged leptons alone. In case (II), the energy distributions obtained by integrating over the rest of phase space is the same for S + P - T as for V - A, and for S + P + T as for V + A. However, the distribution in an angular variable $\chi = \cos^{-1}((\vec{\bar{\nu}} \times \vec{\bar{\mu}}) \cdot (\vec{\bar{\nu}} \times \vec{1}))/|\vec{\bar{\nu}} \times \vec{\bar{\mu}}||\vec{\bar{\nu}} \times \vec{1}|)$ has a greater asymmetry for S + P $\pm$ T than for V $\pm$ A; at high energies, this indicates the presence of T. (Diss. Abstr. Int., B)

19625 RENORMALIZED COUPLING CONSTANTS OF GAUGE THEORIES. Bollini, C. G. (Univ. Nacional, La Plata); Giambiagi, J. J.; Sirlin, A. Nuovo Cim.; 16A: No. 3, 423-436(1 Aug 1973).

Some basic properties of renormalized coupling constants are discussed in the framework of spontaneously broken gauge symmetries. It is pointed out that conventional definitions lead to some difficulties connected with infra-red divergences and two possible solutions are suggested. The ultraviolet divergent contributions to the lowest-order corrections are then studied and it is shown explicitly, in a number of particular examples, how these divergent terms cancel in the interrelations between renormalized coupling constants and masses. The specific calculations are carried out in the unitary gauge of the $SU_2 \times U_1$ gauge model, using the ν-dimensional regularization method. (auth)

19626 SOLUTIONS OF THE CONFORMAL INVARIANT SPINOR EQUATIONS AND THEORY OF THE ELECTRON–MUON SYSTEM. Barut, A. O.; Haugen, R. B. (International Center for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 7: No. 14, 625-628 (4 Aug 1973).

The simplest conformally invariant parity-conserving spinor equation was solved, and the solutions were found to have remarkable properties of describing the electron–muon system with their characteristic differences. (JFP)

19627 UNSYMMETRIC CORE IN A PARTON MODEL DESCRIPTION OF MASSIVE-LEPTON-PAIR PRODUCTION. Schlereth, H. (Technische Hochschule, Aachen). Lett. Nuovo Cim.; 7: No. 14, 685-688(4 Aug 1973).

Using the parton model description for massive lepton pair production from hadron–hadron collisions in the limiting region

$s \to \infty$, Q^2/s finite, Q^2 and s being the invariant masses squared of the lepton pair and the initial hadrons respectively, the lepton pair cross section for small values of Q^2/s is related to electroproduction and neutrino deep inelastic structure functions for the case of a special model of an unsymmetric core which carries isospin. The treatment is based on the conjecture that the small-x behavior of the deep inelastic structure functions is given by Regge theory. The process $p + p \to \mu^+ + \mu^-$ + anything is considered. (JFP)

19628 NEUTRINO AND ELECTROMAGNETIC FIELDS IN CURVED SPACE–TIME. Trim, D. W. Waterloo, Ont.; Univ. of Waterloo (1972). National Library of Canada, Ottawa. Thesis (Ph. D.).

Some aspects of the interaction of an electromagnetic field with a gravitational field in the theory of general relativity can be described invariantly in terms of the principal null directions (pnd's) determined by these fields. The interaction of a (classical) neutrino field with a gravitational field is approached from this point of view. For example, it is proven that if the pnd of the neutrino field is tangent to a geodesic and shear-free null congruence, this null direction k^a is necessarily a repeated pnd of the gravitational field, a result which has a direct analog in the case of the electromagnetic field. Furthermore, the Ricci tensor satisfies $0 = R_{ab}k^ak^b = R_{ab}k^am^b = R_{ab}m^am^b = R_2^2$, where m^a is a complex null vector field orthogonal to k^a. The general line-element satisfying the above algebraic conditions on the Ricci tensor, with k^a tangent to a geodesic and shear-free null congruence, is obtained in a relatively simple form, and is then used to simplify the Einstein-Maxwell and Einstein-Weyl (i.e., combined neutrino-gravitational field equations) field equations, as well as the vacuum gravitational field equations. Finally these equations are solved explicitly subject to an additional assumption on the asymptotic behavior of the Weyl and Ricci tensors. The class of solutions obtained contains the Schwarzschild and Kerr vacuum solutions and their charged counterparts. It is established however that there are no analogous solutions containing a neutrino field. (Diss. Abstr. Int., B)

19629 $\Delta S = 0$ AND $\Delta N' = 1$ NON-LEPTONIC INTERACTION IN THE NEW NAGOYA MODEL. Hayashi, T.; Karino, T.; Matsuda, M. (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 1, 293-303(Jan 1973).

Based on our previous analyses of the possibly new particle observed by Niu's group, some detailed structure of the weak interaction is discussed in connection with the non-leptonic decay processes. The conditions imposed upon decay amplitudes when they are derived from the two-body ($\bar{p}p'$) interaction (or the 15 Hamiltonian) are presented, and also the consequence of the "configuration conservation" rule is examined. Discussion of the ur-baryon "line" picture of hadrons is developed. (auth)

19630 NEUTRINO PRODUCTION OF THE $\Delta(1236)$. Schreiner, P. A.; von Hippel, F. (Argonne National Lab., IL). Nucl. Phys.; B58: No. 2, 333-362(1973).

New data for the reaction $\nu p \to \mu^-\pi^+p$ near 1 GeV/c neutrino momentum are consistent with complete dominance by the quasi-two-body reaction $\nu p \to \mu^-\Delta^{++}(1236)$. It is shown how information about the N-Δ axial current transition matrix element can be extracted from this data. Various predictions for the matrix elements are reviewed and tested against the experimental results. The data are consistent with the PCAC prediction for $d\sigma/dq^2$ near $q^2 = 0$. In contrast to previous findings, Adler's relativistic version of the static model is reasonably successful in fitting the data. Zucker's model also fits the data. Finally, the implications of these results for future experiments are discussed. (auth)

19631 THE K_{l3} DECAY IN LIGHT-CONE ALGEBRA. Abdel Rahman, A. M. M.; Taha, M. O. (Univ. of Khartoum, Sudan). Nuovo Cim.; 16A: No. 2, 209-216(21 Jul 1973).

K_{l3} decay is studied using $SU_3 \times SU_3$ light-cone algebra. Sum rules linking the form factors for $\langle\pi|V_\mu^{K^-}|K^+\rangle$ and $\langle A_1|V_\mu^{K^-}|K^+\rangle$ are derived and discussed. (auth)

19632 SPACE–TIMES ADMITTING NEUTRINO FIELDS WITH ZERO ENERGY AND MOMENTUM. Collinson, C. D.; Morris, P. B. (Univ. of Hull, Eng.). J. Phys., A (London); 6: No. 7, 915-916(Jul 1973).

All space-times admitting a neutrino field having a zero energy-momentum tensor are found. One of the space-times is shown to admit two distinct neutrino fields. (auth)

19633 INTERACTION OF GOLDSTONE NEUTRINO WITH ELECTROMAGNETIC FIELD. Akulov, V. P.; Volkov, D. V. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 17: No. 7, 261-263(5 Apr 1973).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 17: No. 7, 369-373(5 Apr 1973).

Starting from the representation of the neutrino as a Goldstone particle, a phenomenological action integral was constructed which describes the universal interaction of the neutrino with itself and with an arbitrary fermion field. The form of this interaction is determined uniquely from the gauge invariance requirements together with the required invariance with respect to the expanded Poincare group. An expression for the differential cross section is given, and an upper limit on the universal coupling constant is obtained. (LBS)

19634 LEPTON MODEL. Lipmanov, E. M. (Yaroslavl' State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 17: No. 4, 158-161(20 Feb 1973).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 17: No. 4, 222-225(20 Feb 1973).

Attention is called to the possibility of unifying Weinberg's initial SU(2) × U(1) symmetrical lepton model with the classification given by Lipmanov (Zh. Eksp. Teor. Fiz., 43: 893(1962)) for the family of leptons, such that the interactions of the neutral current are naturally eliminated together with the difficulties with the triangular anomalies of the axial current. A lepton classification scheme is considered in SU(2), which leads in a natural fashion to a scheme of universal weak interaction with one four-component neutrino and with maximum parity nonconservation. (LBS)

19635 MODEL OF WEAK INTERACTION BASED ON THE THREE-TRIPLET MODEL OF HADRONS. Fujii, K.; Katuya, M.; Okubo, S.; Tamura, S. (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 49: No. 3, 975-994(Mar 1973).

Possible roles which the internal degrees of freedom in the three-triplet model of hadrons play in weak interactions are investigated. It is pointed out that, if one introduces a charged current $I_{\rho,\alpha}(x)$ (ρ = index of Lorentz vector, $\alpha = 1, \ldots, 4$) of the so-called "double V–A" type which is a certain kind of charged current so extended as to carry the internal degree of freedom contained in the three-triplet model, and assume that the weak interaction is $H_W = (G_0/2\sqrt{2})I_{\rho,\alpha} \cdot I^{\dagger}_{\rho,\alpha}$, then the $|\Delta I| = \frac{1}{2}$ rule is derived for nonleptonic decays of ordinary hadrons (assumed to belong to the SU(3)″-singlet). The purely leptonic interaction obtained from H_W contains "pseudo-diagonal" terms, $(\bar{e}\nu_\mu)(\bar{\nu}_\mu e)$ and $(\bar{\mu}\nu_e)(\bar{\nu}_e\mu)$, but not the so-called diagonal ones. From the semi-leptonic interaction one obtains four kinds of hadronic currents which couple to the electron-, muon-, $(\bar{\mu}\nu_e)$- and $(\bar{e}\nu_\mu)$-currents, i.e., $W_\rho(e; x)$, $W_\rho(\mu; x)$, $W_\rho(\nu_e\mu; x)$, and $W_\rho(\nu_\mu e; x)$. These are different from each other, but, as far as one treats matrix elements between SU(3)″-singlet states, the former two of them give the same values and the latter two have no contributions under the assumption that the symmetry-breaking of strong interaction preserves the SU(3)″-symmetry. In this sense, the μ-e universality holds. Various observable effects expected from our H_W are investigated, in which are included properties of charm-nonconserving interaction, magnitude of the structure functions of deep inelastic neutrino reactions and so on. (auth)

19636 NEUTRINO-INDUCED PRODUCTION AND PARTON CHAINS. Krolikowski, W. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 21: No. 4, 371-379(1973).

A simple parton model of the nucleon which already proved to be in fair agreement with SLAC-MIT electroproduction data is now applied to the neutrino induced production giving a nice fit to CERN data. (auth)

19637 $\Delta I = \frac{1}{2}$ RULE IN NONLEPTONIC WEAK DECAYS. Reid, J. H.; Trofimenkoff, N. N. (Calgary Univ., Alberta, Canada). Progr. Theor. Phys. (Kyoto); 49: No. 2, 612-621(Feb 1973).

The role that final-state interactions might play in producing the $\Delta I = \frac{1}{2}$ rules in $K \to 2\pi$ and nonleptonic hyperon decays is studied. Starting from unsubtracted dispersion relations for the decay amplitudes and using elastic unitarity, integral equations of the Omnès type are obtained for the decay amplitudes. The integral equations are solved and the solutions are evaluated numerically in order to determine the effect of the final-state interactions on the decay amplitudes. The main results are: The final-state interactions are of the nature required to produce the $\Delta I = \frac{1}{2}$ sum rules for $K \to 2\pi$ and nonleptonic Λ and Σ decay amplitudes as well as to give a small parity-conserving $\Sigma^- \to n\pi^-$ decay amplitude; however, they probably also lead to a small parity-violating $\Sigma^- \to n\pi^-$ decay amplitude in contradiction with experiment. It is unlikely that final-state interactions play a role in producing the $\Delta I = \frac{1}{2}$ rule in Ξ decays. (auth)

19638 NUCLEAR FORCES WHICH DO NOT PRESERVE PARITY. Holmberg, L. (Univ. of Stockholm). Kosmos (Stockholm); 48: 93-103(1971). (In Swedish).

An elementary introduction to parity violation in weak interac-

tion processes is given. Experiments verifying the existence of parity violation are described. Interference effects between electromagnetic radiation of electric and magnetic character, forbidden alpha decay, and experiments with light nuclei are discussed. (SW)

Strong (General)

19639 SYMMETRIC GROUP AND MESON BORN AMPLITUDES. Frampton, P. H. (Physics Department, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 7: No. 10, 3077-3091 (15 May 1973).

In this paper we construct Born amplitudes for a theory of nonstrange meson interactions. It is convenient to summarize our results in two parts. (i) Four-particle Born amplitude, A_4. Here we decide to retain two and reject two of four properties possessed by the unit-intercept Euler-B-function model. We retain (a) no odd daughters and (b) summability over permutations; we reject (c) the supplementary condition on the sum of trajectory functions and (d) the Plahte phase identities. The reason for rejecting (c) is simply that the physical masses do not in general fulfill such a condition; one is then forced to reject (d) because without (c) phase identities are inconsistent. Having made these decisions, we show that retention of (a) and (b) guarantees that there be new singularities in the integrand. Regge behavior dictates that these singularities be at the fixed points $x = e^{\pm i\pi/3}$ of a six-element S_3 group with elements $x \to (1 - x) \to x/(x - 1)$. The general form of A_4 is given; it contains a function which is (1) invariant under an S_3 group and (2) analytic everywhere except for possible simple or multiple poles at the fixed points. Some examples lead to the selection of a particularly simple form for A_4 as a physically interesting model for $\pi\pi$ elastic scattering. Some phenomenological consequences of this model are given including the elastic-resonance widths and the status of the soft-pion consistency condition. (ii) N-particle Born amplitude, A_N. By introducing redundant variables and rewriting. A_4 in terms of projective-invariant anharmonic ratios, the integrand becomes invariant under a larger S_4 group. This is convenient because it enables us to extend all factors, including those with fixed-point singularities, from A_4 to A_N. The general formula for A_N is given; its integrand is S_N-invariant. An extension of the specific physically interesting four-pion model is constructed. Evident in the multipionic amplitude is an anticommutative algebra, which we interpret as the signature of underlying fermionic quarks. In our final remarks we urge that the spectrum uniquely implied by these multipionic amplitudes be analyzed and compared in detail with experimental observations of the nonstrange mesonic spectrum. In an appendix we point out that the symmetric group may be used to unify three different previous proposals. Special cases, extrapolated to unphysical mass values, of the present approach include: (1) the unit-ρ-π-intercept A_4 of Veneziano and its A_N extension in the Bardakci-Chan-Goebel-Koba-Nielsen-Ruegg-Sakita-Tsun-Virasoro theory; (2) the unit-ρ-intercept A_4 of Lovelace and Shapiro and its A_N extension by Neveu and Schwarz; (3) the equal-ρ-π-intercept A_4 of Mandelstam and its A_N extension by Gervais and Neveu. (auth)

19640 MASSIVE QUARKS AND DEEP-INELASTIC PHENOMENA. Preparata, Giuliano (Istituto di Fisica-Universita; di Roma, Istituto Nazionale di Fisica Nucleare—Sezione di Roma, Rome, Italy). Phys. Rev. D 7: No. 10, 2973-2980 (15 May 1973).

A possible theory of hadrons in terms of a massive-quark field theory is proposed. Some consequences for deep-inelastic phenomena are worked out. (auth)

19641 INCLUSIVE TWO-PARTICLE RAPIDITY CORRELATIONS AT ISR ENERGIES AND FIREBALL PRODUCTION. Ranft, G.; Ranft, J. (Karl-Marx Univ., Leipzig). Phys. Lett.; 45B: No. 1, 43-47(25 Jun 1973).

ISR data on two-particle rapidity correlations in the region $y_1 \approx y_2$ can be understood in terms of the multiperipheral fireball model and indicate an energy independent upper limit of the average fireball mass. The diffractive contribution to the fireball production leads to characteristic shapes of long range correlations. Data on long range rapidity correlations may be used to determine the fractions of non-diffractive and diffractive one- and two-fireball production. (auth)

19642 CALCULATION OF AVERAGE MULTIPLICITY IN A SIMPLE SCHEME INCORPORATING THE HARARI POMERON-INTERCEPT HYPOTHESIS. Balazs, L. A. P. (Purdue Univ., Lafayette, IN). Phys. Lett.; 45B: No. 1, 40-42(25 Jun 1973).

Average multiplicities are calculated within a simple finite-energy sum rule scheme assuming (i) the conventional multiperipheral and (ii) the Harari hypothesis about the dependence of the Pomeron intercept on the strength of strong interactions. Case (ii) agrees better with experiment. (auth)

19643 DIMENSION-SELECTING DUALITY PRINCIPLE FOR HADRODYNAMICS AND ELECTRODYNAMICS. Tze, H. C. (Univ. of Copenhagen). Lett. Nuovo Cim.; 7: No. 11, 401-407 (14 Jul 1973).

A possible solution is proposed for the puzzle in strong-interaction physics of the central importance of 2-dimensional field theories in describing processes in the 4-dimensional world. A dual theory is constructed and examples of maximal and minimal dual theories are discussed. The dimension-selecting duality principle is shown to be universal as it is obeyed by electrodynamics as well as the hadrodynamics of strings. It is further shown that duality can be viewed as a geometrodynamical principle asserting the equivalence of dual dynamics and geometry. (LBS)

19644 DIFFICULTY IN FORMULATING RELATIVISTIC PARTONLIKE EQUATIONS. Van Dam, H. (Univ. of North Carolina, Chapel Hill); Han, M. Y.; Biedenharn, L. C. Lett. Nuovo Cim.; 7: No. 11, 408-412(14 Jul 1973).

It is shown that one may interpret the set of generalized new Dirac equations as providing an explicit Poincaré invariant solution to the problem of two point subparticles interacting via action-at-a-distance forces in quantal front subdynamics. It is pointed out that electromagnetic interactions characteristic of a charged particle are forbidden in this system, which may lead to the difficulty of extending parton models into the Poincaré world and maintain at the same time proper electromagnetic interactions. (LBS)

19645 MULTIPERIPHERAL MODEL FOR LOW-MULTIPLICITY INTERACTIONS AT ULTRAHIGH ENERGIES. Shivpuri, R. K. (Clarkson Coll. of Tech., Potsdam, NY); Jha, S. K. Lett. Nuovo Cim.; 7: No. 11, 413-418(14 Jul 1973).

It was previously proposed that a gap in the angular or momentum distribution of secondary particles (fireball-type event) can be explained on the basis of the multiperipheral mechanism for a schizophrenic pomeron. It is shown that the features of the low-multiplicity events at ultrahigh energies are in contradiction with the predictions of the multiperipheral model. (LBS)

19646 PARTICLE PRODUCTION AT LARGE TRANSVERSE MOMENTUM. Berger, E. L.; Branson, D. (CERN, Geneva). Phys. Lett.; 45B: No. 1, 57-62(25 Jun 1973).

From a simple fragmentation approach to inelastic production at large fixed angles, an inclusive cross section is obtained which falls as an inverse power of large transverse momentum p_T and which scales according to $(p_T/\sqrt{s})$, both consistent with ISR data. Predictions for charge ratios and associated multiplicities are also presented and compared with available data. (auth)

19647 FIXED POLES, t-CHANNEL UNITARITY, AND RISING CROSS SECTIONS. Barnett, R. M. (Univ. of California, Irvine). Phys. Lett.; 45B: No. 1, 53-56(25 Jun 1973).

If the Pomeron is a fixed pole, it must be "shielded" from t-channel unitarity by a special type of cut. It is shown how to obtain such a cut. There are no arbitrary parameters between the cut and the pole, and definite predictions of rising cross sections, shrinkage and (ReF)/(ImF) result. These are found to be in good agreement with high energy data. Previously a very similar cut (with similar fits) was obtained, but use of an exotic trajectory is no longer required. (auth)

19648 NORMAL DISTRIBUTION IN TWO VARIABLES AS A MODEL FOR PRODUCED-PARTICLE MULTIPLICITY DISTRIBUTIONS. Parry, G. W.; Rotelli, P. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 7: No. 14, 649-653(4 Aug 1973).

The form of normal distribution in two variables is proposed as a possible description of the distribution in the number of charged particles and the number of neutrals in inelastic collisions which is in principle experimentally measurable. It has the aesthetically appealing feature that the y and x variables enter in a similar fashion which is expected from symmetry between the different charge states of produced particles. The model is intended to be applicable to any inelastic scattering process. (JFP)

19649 ANALYSIS OF RAPIDITY-p_T CORRELATION IN THE MULTIPLE PARTICLE PRODUCTION. Use of the Lightlike Variables. Kimura, K.; Namiki, M.; Ohba, I.; Suzuki, N. (Waseda Univ., Tokyo). Lett. Nuovo Cim.; 7: No. 12, 465-469(21 Jul 1973).

A new plot to show the rapidity-p_T correlation by making use of lightlike variables is proposed, in order to analyze the structure of the particle distribution in high-energy multiple particle production. Several examples of analyses of experimental data by means of the new plot are shown. (LBS)

19650 REGGE LIMIT AND SCALING IN A DUAL MODEL OF CURRENTS. Cremmer, E.; Scherk, J. (CERN, Geneva). Nucl. Phys.; B58: No. 2, 557-597(1973).

A model is presented of off-shell dual amplitudes satisfying duality, factorization, absence of exotics, having no unphysical singularities and reproducing the N-point function of the conventional dual model on the mass shell. These off-shell amplitudes can be identified with currents, however, the s-channel asymptotic behavior of the Compton off-shell amplitude yields only moving poles but no fixed poles. Further, the Bjorken limit at t = 0 yields scaling behavior, but with anomalous dimension, at the expense of having Gaussian form factors. This suggests that a pure current-hadron bootstrap scheme based on the quarkless conventional dual model describes a too soft structure to be able to incorporate fixed poles, canonical scaling and power-behaved form factors. (auth)

19651 PROPERTIES OF TWO-VARIABLE EXPANSIONS OF SCATTERING AMPLITUDE. Znojil, M. (Inst. of Nuclear Physics, Rez, Czech.). Czech. J. Phys.; 23: No. 7, 685-695(1973).

Two types of invariant expansions of scattering amplitude based on group O(3,1) that can be considered as generalizations of the partial wave analysis are studied. They are shown to be identical with the Fourier transform of the modified partial waves, the modification being given by integrating or differentiating the partial wave. A simple physical use of expansion coefficients, the so-called Lorentz amplitude, is sought for, and the connection between the poles of Lorentz amplitude and the high energy behavior of the partial wave is found; the relation between the Lorentz amplitude and the position of the Regge poles is precisely formulated. (auth)

Strong (Baryon No. = 0)

19652 (COO-1428-318) ZEROS OF THE VECTOR MESON PRODUCTION AMPLITUDE AND THEIR IMPLICATIONS. Gutay, L. J.; McIlwain, R. L.; Vasavada, K. V.; Meiere, F. T. (Purdue Univ., Lafayette, Ind. Dept. of Physics; Indiana-Purdue Univ., Indianapolis. Dept. of Physics). 1972. 11p. Dep. NTIS $3.00.

In studying the single pion production amplitudes in the vector meson mass range (ρ and K*) zeros and structures in $\mathrm{Re}\rho_{00}^{\dagger}$ and $\rho_{1-1}^{\dagger}$ density matrix elements were observed. The zero of $\mathrm{Re}\rho_{00}^{\dagger}$ is observed to be approximately independent of beam momentum, charge state or strangeness of the vector meson and is invariant under s-t crossing at $\Delta^2 \approx m_V^2 - m_{Pa}^2$. This gives a strong support to absorptive models. The analysis shows inconsistences in the recent amplitude analysis. (auth)

19653 (COO-1545-126) WHAT CAN WE MEASURE IN ρ-ω INTERFERENCE EXPERIMENTS? Rabl, A.; Reay, N. W. (Ohio State Univ., Columbus. Dept. of Physics). 1972. Contract AT(11-1)-1545. 10p. Dep. NTIS $3.00.

It is shown that $\rho-\omega$ interference, if studied in pionic production of both 2π and 3π final states, may allow an experimental separation of the phase of the mixing parameter from the phase difference of the ρ and ω production amplitudes. It is pointed out that the mixing parameter measured in 2π final states differs from the one measured in 3π final states, unless certain isospin breaking amplitudes are sufficiently small. (auth)

19654 (LBL-1772) NEW Kπ PARTIAL WAVE ANALYSIS BELOW 1 GeV Kπ MASS. Barbaro-Galtieri, A.; Matison, M. J.; Alston-Garnjost, M.; Flatte, S. M.; Friedman, J. H.; Lynch, G. R.; Rabin, M. S.; Solmitz, F. T. (California Univ., Berkeley. Lawrence Berkeley Lab). June 1973. Contract W-7405-eng-48. 28p. (CONF-730319-5). Dep. NTIS $3.50.

From international conference on π-π scattering as associated topics; Tallahassee, Florida, USA (28 Mar 1973).

The Kπ scattering for M(Kπ) < 1 GeV was studied in the reaction $K^+p \to \Delta^{++}K^+\pi^-$ at 12 GeV/c incident K^+ momentum. Both the moments of the Kπ angular distribution and the Kπ cross section are extrapolated to the pion pole, and the results are used in a partial wave analysis. For the s wave both an energy-independent and an energy-dependent partial wave analysis were done. It is found that only the so-called "down" solution is compatible with the data; that is, a phase shift $\delta_0^{\frac{1}{2}}$ slowly increasing from 20° at 800 MeV to 60° at 1000 MeV. No evidence for an s-wave resonance near the K*(890) mass is found, although a resonance with $\Gamma < 7$ MeV cannot be excluded by the data. The "down" solution is well represented by an effective range formula with $a_0^{\frac{1}{2}} = -0.33 \pm 0.05$, in good agreement with a current algebra calculation. (auth)

19655 HIGH-ENERGY BEHAVIOR OF GAUGE-THEORY TREE GRAPHS. Schechter, J. (Physics Department, Syracuse University, Syracuse, New York 13210); Ueda, Y. Phys. Rev. D 7: No. 10, 3119-3123 (15 May 1973).

The unitarity-bounded high-energy behavior of Born graphs for production of two massive vector mesons is shown to result from the decomposition of the amplitude into a locally gauge-invariant part and a suppressed remainder. In addition, asymptotic helicity conservation is found to emerge. (auth)

19656 $p\bar{n}$ BOUND STATES AS EVIDENCE FOR FERMI-YANG NUCLEON QUARKS. MacGregor, M. H. (Univ. of California, Livermore). Particles Nucl.; 5: No. 2-3, 69-76 (1973).

A number of arguments suggest that the mass of the quark should be divorced from its nonobservability. If this is done, then quark systematics pinpoint the mass of the nucleon quark at about 330 MeV. In quantitatively reconciling a 330 MeV mass with a 939 MeV nucleon mass and a 1795 MeV $p\bar{n}$ mass, a Fermi-Yang type of nucleon ($N = Q\bar{Q}Q$) is obtained with Yamaguchi coupling ($QQ = \bar{Q}\bar{Q} \cong 0$, $Q\bar{Q}$ = dominant), rather than to the Gell-Mann and Zweig formulation ($N = QQQ$). (auth)

19657 PROTON-ANTIPROTON SCATTERING NEAR THRESHOLD. Lemke, J. L. (Univ. of Chicago). Nuovo Cim.; 16A: No. 3, 473-510(1 Aug 1973).

Recent experiments and theoretical conjectures suggest the presence of unusual features in antiproton-proton scattering near elastic threshold. The content of three classes of simplified phenomenological models of $\bar{p}$-p scattering in the very-low-momentum region ($P_{lab} \lesssim 350$ MeV/c) was analyzed. The models show striking differences in the expected threshold behavior of cross sections and the slope of the forward scattering peak. It is found that the published data strongly favor a class of resonance-dominance models which possess some features of the dual-resonance spectrum. Models with smoothed absorptive amplitudes and those which emphasize structure below threshold would be ruled out. The analysis presented here makes it possible to discriminate between models on the basis of gross features of the data and to interpret systematically the consequences for a choice of model by using new data as they become available. A brief discussion of the apparent non-S-wave behavior near threshold in terms of possible longer-range forces in the $\bar{p}p$ system is presented, and the usefulness of several types of further experiments on $\bar{p}$-p in the low-momentum region is discussed. (auth)

19658 MASS RENORMALIZATION FOR A VECTOR MESON. Chiang, C. C.; Chiu, C. B. (Univ. of Texas, Austin). Nuovo Cim.; 16A: No. 3, 511-528(1 Aug 1973).

Results are presented on the mass renormalization of a vector meson within the framework of shadow-state theory based on the techniques of the Feynman diagram, the unitarity and dispersion relations. The analytic result obtained from the conventional renormalization prescription is contrasted with the piecewise analytic result from the shadow-state theory. (auth)

19659 INTEGRAL RELATION FOR THE t-DEPENDENCE OF THE $I_t = 1$ $\pi\pi$ ABSORPTIVE PART. Basdevant, J. L.; Schomblond, C. (Laboratoire de Physique Theorique et Hautes Energies, Paris). Phys. Lett.; 45B: No. 1, 48-52(25 Jun 1973).

A sum rule relating the $I_t = 1$ $\pi\pi$ absorptive part $\Delta(s,t)$ tc integrals over total cross sections is derived. It is shown how it can be used to estimate the t-dependence of this absorptive part and in particular its zero. A recent low energy $\pi\pi$ phenomenological analysis seems to imply a zero near $t = -0.2$ GeV^2 for large s. (auth)

19660 COUPLINGS TO VECTOR MESONS IN THE RELATIVISTIC QUARK MODEL. de Deus, J. D. (University Coll., London). Port. Phys.; 6: No. 3, 163-181(1971).

Hadron couplings are evaluated using quark graphs and the Bethe-Salpeter formalism. Electromagnetic decays of vector mesons calculated in this way are shown to be consistent with the $\omega-\varphi$ current mixing model. A value $\theta = 33°$ is predicted. Baryon couplings are discussed in the same formalism. When nonrelativistic conditions are imposed the model reproduces the usual additivity results with corrections. (auth)

19661 DUAL, CROSSING-SYMMETRIC REPRESENTATIONS WITH FINITE-WIDTH RESONANCES AND REGGE ASYMPTOTIC BEHAVIOR. Gaskell, R. W. (Carleton Univ., Ottawa). Nuovo Cim.; 16A: No. 2, 315-344(21 Jul 1973).

A class of dual, crossing-symmetric representations having finite-width resonances and Regge asymptotic behavior for all physically attainable regions of the crossed-channel variables is obtained. One of these representations is examined in detail. A number of physical applications are also presented including an explanation of the Dalitz-plot distribution for $\bar{p}n \to 3\pi$, the behavior of the most important $\pi\pi$ phase shifts and a determination of the $\pi\pi$ S-wave scattering lengths. (auth)

19662 NONLINEAR QUARK THEORY OF A FIELD OF SPIN S = 2 (OF GRAVI-MESONS). II. Kurdgelaidze, D. F.; Funke, Kh. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 7-11(1973). (In Russian).

A fermion equation of spin $s = 1/2^+$ and $s = 3/2^+$ was developed by a fusion method within the framework of nonlinear quark theory, allowing for the interaction with 27-plet mesons of spin $s = 2$(27-plet gravimesons). The case of baryons of $s = 1/2^+$ was examined, and after the corresponding computations imparted to the equation for a baryon octet a form of a spinor field equation in warped space (the Fock-Ivanenko equation) and determined the effective metrics through 27-plet gravimesons. (tr-auth)

19663 TWO TOPICS ON MESON–MESON SCATTERING. Kang, J. S. Stony Brook, NY; State Univ. of New York (1972). 74p. University Microfilms Order No. 73-13,624.

Thesis (Ph.D.).

A model of the low energy pion-pion scattering amplitudes is constructed which is consistent with the usual partial wave analyticity, elastic unitarity, and crossing symmetry in the s- and p-wave channels. The crossing relations are expressed as five Roskies conditions on the s- and p-wave amplitudes. The subtraction constants are chosen to agree with current algebra constraints. The partial wave amplitudes are constructed by the N/D method after approximating the left-hand singularities by a few poles. The pole structure is then determined self-consistently by requiring the Roskies conditions and the current algebra conditions of the derivatives of the amplitudes at subtraction points to be satisfied. The resulting amplitudes, which should be a good approximation below 1 GeV, are in qualitative agreement with available experimental data. The ρ and σ mesons are generated through self-consistency. The I = 0, s-wave has a broad resonance at about 700 MeV. The location of the ρ meson is in agreement with experiment, but the width is somewhat larger than the experimental value. The I = 2, s-wave phase shifts are repulsive and small, in agreement with experiment. The chiral SU(2) ⊗ SU(2) is studied for the πK scattering in the scheme of the linear realization. Roskies type relations are used for the crossing symmetry and the relativistic version of the effective range approximation is imposed on for unitarity. Two alternatives of the up-down ambiguity for the $I = 1/2$, 0^+ resonance are investigated, and the analysis favors the up-solution with $\chi(870)$. The sigma term in the πK scattering is estimated to be about $-1.1\ m_\pi^2$. This is another measure of the chiral SU(2) ⊗ SU(2) breaking and consistent with other features of the symmetry breaking. Finally the threshold effect on the K_{l3} form factor is studied and compared with experiment. (Diss. Abstr. Int., B)

Strong (Baryon No. = 1)

Refer also to abstracts 19543 and 19552.

19664 (LBL-1788) PART I. AN ESTIMATE OF THE POMERANCHUKON-ρ CUT FOR π-NUCLEON SCATTERING. PART II. FIXED POLES AND FESR FOR K^+p SCATTERING. Dubovoy, M. (California Univ., Berkeley. Lawrence Berkeley Lab.). 4 Jun 1973. Contract W-7405-eng-48. 79p. Dep. NTIS $6.00.

Thesis.

It is shown that it is plausible to find nonsense wrong signature zeroes (NWSZ) in inclusive reactions. It is briefly reviewed how they appear in certain models, and then some model independent arguments are given that make their existence in certain cases a strong possibility. In particular, by using finite missing mass sum rules (FMMSR) it is shown that the triple-Regge residue $g_{P\rho}^{\rho}(t)$ probably has a NWSZ at t = 0. A parametrization of $g_{P\rho}^{\rho}(t)$ for small t is then proposed, and this particular coupling is estimated phenomenologically. Using this estimate of $g_{P\rho}^{\rho}(t)$ the contribution of the ρ-P cut to the total πN cross section is estimated, the polarization is calculated in π^-p charge exchange scattering as a ρ-pole ρ-P cut interference. It is found that it is possible to obtain a fairly good fit to the polarization for values of the parameters that are consistent with experiment, and furthermore, it is found that the fit to the polarization is very sensitive to the small t behavior of $g_{P\rho}^{\rho}(t)$. Assuming that exchange degeneracy is exact, the residue of the Pomeranchukon trajectory for K^+p elastic scattering is calculated from finite-energy sum rules and the low-energy phase shifts. It is shown that in order to be consistent with some recent results on s-channel helicity conservation for Pomeranchukon-dominated processes, at least one fixed pole must be included in the B amplitude, and in particular, this consistency is achieved by introducing a fixed pole at J = 0. (auth)

19665 MESON FIELD INTERACTING WITH A HEAVY SOURCE. Bolsterli, M. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New New Mexico 87544). Phys. Rev. D 7: No. 10, 2967-2973 (15 May 1973).

The nonrelativistic theory of a meson field interacting with a heavy source is treated in a self-consistent field approximation. The energy is obtained and compared with the static model. The mesonic contribution to the mass is computed. Subtraction of the center-of-mass kinetic energy gives an improved value for the energy of the system. Excitations of the system and meson scattering are discussed briefly. (auth)

19666 REGGE POLE AND CUT CONTRIBUTIONS TO πN CHARGE-EXCHANGE SCATTERING. Collins, P. A.; Williams, R. M. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 7: No. 13, 533-540(28 Jul 1973).

Various models that have been proposed to explain the unexpected features of the πN amplitudes are briefly reviewed. An investigation is made of the nature of the ρ-pole and Regge-cut contributions to the charge-exchange πN amplitudes, without adopting any particular model. It is shown that there is a significant cut contribution to the flip amplitude and that this is of a constructive nature. In the nonflip amplitude, for $t > -1$ the cut is destructive except for the real part at small angles. The results also provide strong evidence that the ρ chooses nonsense in the nonflip amplitude. (LBS)

19667 GENERALIZED VECTOR DOMINANCE, DEEP INELASTIC ELECTROPRODUCTION, AND NEUTRON–PROTON MASS DIFFERENCE. Majumdar, R. (CERN, Geneva). Lett. Nuovo Cim.; 7: No. 14, 593-598(4 Aug 1973).

The various finite contributions to the neutron–proton electromagnetic mass difference are estimated based on the generalized vector-dominance model, and the corresponding results are compared with those based on the usual ρ dominance model. It is emphasized that the effect of continuum in the generalized vector dominance model may enhance the fixed-pole contribution substantially. (JFP)

19668 MISSING-CLUSTER ANALYSIS OF MULTIPLE PRODUCTION. Abud, M.; Hama, Y. (Univ., Sao Paulo, Brazil). Lett. Nuovo Cim.; 7: No. 14, 659-664(4 Aug 1973).

An analysis is reported showing that provided the mass spectrum of the cluster is suitably chosen the missing-cluster analysis may provide all the features of the presently known experimental data such as the energy dependence and scaling property. The average charged multiplicity is shown as a function of massing mass for the reaction $\pi^+ + p \rightarrow \pi^+ +$ anything at 16 GeV/c with selection of leading π^+. (JFP)

19669 COULOMB CORRECTIONS TO πN ELASTIC SCATTERING. Bugg, D. V. (Queen Mary Coll., London). Nucl. Phys.; B58: No. 2, 397-407(1973).

The effect of the Coulomb barrier on πN elastic scattering below 300 MeV is calculated. Its contribution to the difference in width between Δ^0 and $\Delta^{++}(1231)$ is estimated to be 3.9 ± 0.5 MeV. The effects of charge differences in the u-channel Δ and N poles are also estimated using the method of Dashen and Frautschi. (auth)

19670 EXPERIMENTAL DETERMINATION OF PARITY-DOUBLET CONTRIBUTIONS IN BARYON-EXCHANGE REACTIONS. Ader, J. P. (Laboratoire de Physique Theorique, Bordeaux); Meyers, C.; Salin, P. Nucl. Phys.; B58: No. 2, 621-632(1973).

Very simple relations between differential cross sections and polarizations in backward scattering (baryon exchange) which allow an experimental separation of parity-doublet contributions are pointed out. It is shown, for instance, that in πN elastic scattering, the cross sections with nucleon polarization parallel or antiparallel to the normal of the scattering plane are, respectively, proportional to unnatural or natural parity exchange. A rapid survey of available experimental data in πN elastic exchange. A rapid survey of available experimental data in πN elastic scattering and $\pi^-p \rightarrow K^0\Lambda$ exhibits unexpected features. (auth)

19671 SYSTEMATICS OF MULTIPLICITY DISTRIBUTIONS. Krzywicki, A. (CERN, Geneva). Nucl. Phys.; B58: No. 2, 633-640(1973).

The original arguments of Koba, Nielsen and Olesen are combined with an assumption about isosinglet exchange dominance of the $N \rightarrow N$ forward scattering amplitude. Implications for the systematics of multiplicity distributions and correlations between the number of charged and neutral secondaries are pointed out and compared with available data. Further experiments are suggested. (auth)

19672 CALCULATION OF SPIN DEPENDENCE IN THE ABSORPTION MODEL FOR π-EXCHANGE. Wagner, F. (Max-

Planck Institut fuer Physik und Astrophysik, Munich). Nucl. Phys.; B58: No. 2, 494-512(1973).

A generalization of the absorption model of Williams done for the reaction $\pi^-p \to \pi^-\pi^+n$ is presented for arbitrary π^+B final states in the reaction $Bp \to B\pi^+n$. For small values of the π^+B crossing angle the results can be expressed in terms of the π^+B scattering amplitude instead of the π^+B partial-wave amplitudes. By this a considerable simplification of the general formalism is achieved. Some of the predictions which can be made turn out to be independent of the π^+B amplitudes. This allows a sensitive test also in the case of $B = \pi$ or K, where the πB amplitudes are unknown. (auth)

19673 A_2 EXCHANGE IN THE REACTION $\pi^-p \to \pi^-\pi^+n$ AT 17.2 GeV/c. Kimel, J. D.; Reya, E. (Florida State Univ., Tallahassee). Nucl. Phys.; B58: No. 2, 513-524(1973).

Absorptive A_2 exchange is studied using the recent high statistics $\pi^-p \to \pi^-\pi^+n$ CERN-Munich data at 17.2 GeV/c. The model amplitudes are compared with a recent amplitude analysis and their importance for polarized target measurements (imaginary parts of density matrix elements) is discussed and high-energy predictions given. (auth)

19674 HELICITY CONSERVATION AND THE DRELL-HIIDA-DECK EFFECT. Kagiyama, S. (Fukuoka Univ.); Uehara, M. Progr. Theor. Phys. (Kyoto); 49: No. 1, 216-226(Jan 1973).

Coexistence of the Drell-Hiida-Deck effect and true A_1 resonance production fairly explains the complicated experimental situation that angular distributions of the normal to the decay plane appear as if the t-channel helicity were conserved but those of the ρ meson coming from the decay seem not to conserve the t-channel helicity. It is shown that the true A_1 resonance conserves the t-channel helicity and its decay into the $\rho\pi$ state occurs through the d wave dominantly. The angular distributions by the Drell-Hiida-Deck effect are studied also for the $\pi^+\pi^-p$ state diffractively produced. Conclusions similar to those for the A_1 mass region hold for the low mass $\pi^+\pi^-p$ system. (auth)

19675 DOUBLY CHARGED A_1^{3-} AND EXISTENCE OF THE TRUE A_1 RESONANCE. Uehara, M. (Kyushu Univ., Fukuoka). Lett. Nuovo Cim.; 17: No. 12, 473-476(21 Jul 1973).

The existence of the A_1 as a true resonance and its contribution to the $\rho\pi$ mass distribution in the processes $\pi^+p \to \rho^0\pi^+p$ and $\pi^-n \to \rho^-\pi^-p$ is discussed. Three problems are suggested for obtaining important information for the existence of the true A_1: charge-exchange A_1^0 production; decay angular distributions; and cross-over of Q^0 and $\bar{Q}^0$ production in $K_L p$ interactions. A scheme is presented which is summarized as follows: The diffractively produced A_1 or Q bump is composed of two components, the one is the kinematical effect which gives the s-wave $\rho\pi$ mode and the other is the A_1 resonance which may decay mainly into the d-wave $\rho\pi$ mode. (LBS)

19676 ANALYSIS OF CHEW-LOW INTEGRAL EQUATION. Okubo, S. (Inst. of Theoretical Physics, Goteborg). Nuovo Cim., A; 16A: No. 2, 241-260(21 Jul 1973).

It has been analytically shown that the Chew-Low integral equation for the static pion-nucleon scattering problem does not have a solution for the case of no cut-off or for slowly decreasing cut-off functions. Also, for general cut-off functions, the equation can be shown to have no solution for large coupling constants. For the strong-coupling limit the new bound state N* must have the isospin $\frac{1}{2}$ and the spatial spin $\frac{1}{2}$ in order to be consistent with analyticity, crossing and unitarity. The mass of N* and the coupling constant must satisfy some equality and inequalities which are consistent with results of the strong-coupling theory. (auth)

19677 DIFFRACTIVE PRODUCTION OF NONSTRANGE MESONS IN THE HARMONIC-OSCILLATOR QUARK MODEL. Le Yaouanc, A.; Oliver, L.; Pene, O.; Raynal, J. C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim.; 16A: No. 2, 261-276(21 Jul 1973).

To describe the diffractive production of nonstrange mesons we use quark model harmonic-oscillator wave functions, a treatment of recoil which has proven successful for N*'s diffractive production and a determination of quark spin-flip amplitude from πN elastic-scattering s-channel centre-of-mass helicity conservation. There is no fitted parameter except the forward value and slope of the quark-quark spin-nonflip elastic amplitude deduced from πN elastic scattering. Wave function parameters were deduced from meson and baryon Regge slopes. This work is in the same line as Levin and Frankfurt and Clegg's but goes much further; absolute calculations are made, and a discussion of which predictions are specific to quark model is presented. A complete success for A_2 (diffractive character, total and differential cross-sections, density matrix) and also for A_3 as much as experimental comparison is possible. For A_1, discussing the background puzzle, agreement is found for the total cross-section and the diffractive character of the production. (auth)

19678 SIMPLE MODEL FOR THE π^+-p BREMSSTRAHLUNG PROCESS. Thompson, R. H. (Los Alamos Scientific Lab., NM). Nuovo Cim.; 16A: No. 2, 290-298(21 Jul 1973).

A simple model using the usual Schrödinger, nonrelativistic current operator is used to calculate the process $\pi^+p \to \pi^+p\gamma$ in the region of the 1236 resonance. This model provides a mechanism which suppresses the influence of the pion-nucleon resonance on the spectrum of the emitted photon. (auth)

19679 SINGLE PARTICLE DISTRIBUTIONS IN THE SMALL X REGION. Sakai, S. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 2, 552-561(Feb 1973).

Single particle distributions are investigated in the multiperipheral model. The result says that in the small x region ($|x| \leq 0.2$), the distribution functions depend on $m_a^2 x^2\theta(x)$ $(m_b^2 x^2\theta(-x))$ and $m_c^2 + k_\perp^2$, where a(b) is the projectile (target) and c is the detected secondary. The x- and $k_\perp^2$-dependences of the distribution functions are more sensitive for smaller m_a^2 and larger $m_a^2(m_b^2)$. These features are supported by experimental data, and the model fits the data on both the transversal and longitudinal momentum distributions in the following collisions quite well: $\pi^+ + p \to \pi^- + \text{"X"}$, $K + p \to \pi + \text{"X"}$, $p + p \to \pi + \text{"X"}$, $\gamma + p \to \pi + \text{"X"}$, $p + p \to K + \text{"X"}$, $K^+ + p \to K^0 + \text{"X"}$, $K^- + p\ K^0 + \text{"X"}$ and $\gamma + p \to K + \text{"X"}$. The K/π ratio becomes 0.11, which is also in good agreement with the present experimental results. (auth)

19680 LEADING LIGHT-CONE SINGULARITIES AND HADRON COLLISIONS. Iizuka, J.; Okamura, H. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 2, 622-633(Feb 1973).

The contribution from the leading light-cone singularities to the total cross sections for γ-hadron and vector meson-hadron collisions is studied by applying the Fourier transformation with time-like momenta to the known part of the current commutator function near the light-cone. The spectral function introduced in the modified causal function is favored to have a broad spectrum with a finite support. A similar analysis is also made for pseudoscalar meson-hadron collisions. In all cases, the contribution has a common form of structure functions times the spectral function and represents a major part of the continuum in the nondiffractive component. Based on this result, a unique division of the nondiffractive component into the continuum and the resonance-dominated part is suggested in contrast to the duality approach. (auth)

19681 STRONG DECAY RATE OF BARYON RESONANCES IN A TWO BODY COMPOSITE BARYON MODEL. Ono, S. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 2, 573-585(Feb 1973).

The two-body composite model of baryons, proposed previously, is used to calculate the strong decay rates: baryon resonance → baryon (or baryon resonance) + pion. The predicted rates agree well with experimental ones except for the Λ-resonances ($I = 0$, $Y = 0$). (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 19816, 19817, and 20016.

19682 (COO-3001-42) NUCLEON-NUCLEON INTERACTION AND THE INTERACTION OF NUCLEONS WITH ISOBARS. Brown, G. E. (State Univ. of New York, Stony Brook). 1973. Contract AT(11-1)-3001. 17p. (CONF-730642-1). Dep. NTIS $3.00.

From fifth international conference on high-energy physics and nuclear structure; Uppsala, Sweden (18 Jun 1973).

The origin of the nucleon-nucleon interaction from the exchange of the π- and ω-mesons and from two-pion exchange, is discussed. The two-pion exchange term is described in a dispersion theoretical formalism, and it is shown how the π-π scattering phase shift $\delta^{I=0}_{\pi\pi}$ governs the strength of the σ-degrees of freedom. Going over to dynamical models, the interaction of nucleons with the N^*_{33}-isobar is discussed. A model for the two-pion exchange involves the virtual isobar as intermediate state. The presence of virtual isobar is seen, perhaps most clearly, in the process $n + p \to d + \gamma$. The isobar also enters into various exchange current corrections to magnetic moments and β-decay. Using any one of several simple models for the isobar, a consistent picture of the various phenomena in the two- and three-nucleon systems can be achieved. (auth)

19683 (IC-72/23) SPIN STRUCTURE IN THE NUCLEON-DEUTERON CROSS-SECTION DEFECT. Alberi, G.; Gregorio, M. A. (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1972. 8p. INIS.

The double spin-flip contributions to the neutron-deuteron cross sections defect are calculated at intermediate energies using the Glauber theory. (auth)

19684 (LA-UR-73-889) NAIVE VIEW OF HIGH ENERGY HADRON-NUCLEUS COLLISIONS. Goldhaber, A. S. (Los Alamos Scientific Lab., N. Mex.). 1973. 7p. (CONF-730642-3). Dep. NTIS $3.00.

From fifth international conference on high-energy physics and nuclear structures; Uppsala, Sweden (18 Jun 1973).

High energy (1000-GeV) nucleon-nucleus collisions in emulsion give an indication of the nature of multiple interactions of very fast "excited hadrons." The data suggest that a cascade model of successive hadron production is not as close to the truth as a two-fireball model, in which at least the fast fireball does not disintegrate before leaving the nucleus, unless it is multiply excited by several successive collisions. (auth)

19685 (RLO-1388-653) REGGEON THEORY OF DIFFRACTION SCATTERING. Baker, M. (Washington Univ., Seattle. Dept. of Physics). 1973. 33p. (CONF-730334-5). Dep. NTIS $3.75.

From eighth Recontre de Moriond conference; Meribel-les-Allues, France (4 Mar 1973).

Gribov's theory of the Pomeron is reviewed and compared to the recent ISR proton-proton elastic scattering data. (auth)

19686 PARTIAL WAVE ANALYSIS OF NUCLEON- NUCLEON BETHE-SALPETER EQUATION ON THE COMPUTER. Fleischer, J. (Los Alamos Scientific Lab., NM). J. Comput. Phys.; 12: No. 1, 112-123(May 1973).

The main features of a code in the formula manipulating language REDUCE are presented for the evaluation of Bethe-Salpeter kernels for NN scattering. The starting point is a recent work of J. J. Kubis, who gave an algorithm for the partial-wave analysis of spinor Bethe-Salpeter equations in terms of the helicity formalism. Applications of these kernels apart from the evaluation of the Bethe-Salpeter equations include, for example, "matrix" -Padé approximates for partial waves. (auth)

19687 STUDY OF PION-DEUTERON REACTIONS IN THE RESONANCE REGION AS A THREE-BODY PROBLEM. Myhrer, F. Rochester, NY; Univ. of Rochester (1973). 165p. University Microfilms Order No. 73-14,828.

Thesis (Ph. D.).

An examination of the pion-deuteron elastic scattering and the pion-deuteron absorption reaction in the resonance region was made. The pion-deuteron reactions were solved by using the Faddeév three-body formalism. To describe the two-body scattering amplitudes, the separable model was used, and in this model a set of linear integral equations coupled by angular momenta was derived. This three-body formalism allowed one to examine easily the effects the intermediate nuclear excitations had on the pion-deuteron reaction amplitudes. It is discussed what effects the bound nucleons, the intermediate nucleon excitations, and the pion-nucleon multiple scatterings will have on the location of the resonance energy for the pion-deuteron elastic scattering. Then the Faddeév formalism is extended to include the reaction $\pi^+ d \rightarrow pp$ where all initial and final state interactions are included. The initial state is a three-body system which is solved taking all two-body interactions into account. This solution gives the correct distorted three-body wave function including the intermediate deuteron excitations. This wave function is compared with what a distorted wave treatment of the pion-deuteron state would give. Both pion-deuteron elastic scattering and the pion-deuteron absorption reaction are solved numerically for different S- and P-wave pion-nucleon scattering models. (Diss. Abstr. Int., B)

19688 NEW MULTIPLICITY DISTRIBUTION FROM A SIMPLE REGGEIZED PRODUCTION MODEL. Barshay, S.; Rostokin, V. (Univ. of Copenhagen). Lett. Nuovo Cim.; 7: No. 13, 563-567 (28 Jul 1973).

A simple model is suggested for production of two clusters via Reggeon exchange in very-high-energy proton-proton collisions. The model incorporates certain basic physical features of both the diffractive models and of the multiperipheral models. A multiplicity distribution for pions is suggested which exhibits the following features: the apparent broadening of the distributions with increasing energy, and the strong drop in the partial cross sections $\sigma_n(s)$ by $n \gtrsim 2.5\ \langle n(s) \rangle$. (LBS)

19689 MULTIPLICITY DISTRIBUTION, TWO-COMPONENT MODEL OF PARTICLE PRODUCTION AND INTERCEPT OF THE REGGE TRAJECTORY. Minami, S. (Osaka Univ.). Lett. Nuovo Cim.; 7: No. 11, 419-422(14 Jul 1973).

A simple expression of the inelastic cross section σ_{2n+2} is suggested which consists of the diffractive and nondiffractive components (σ^D_{2n+2} and σ^π_{2n+2}), and it is shown that a good fit to the data for the multiplicity distribution in inelastic pp scattering can be obtained by the model. It is also shown that a reasonable value of the intercept α_R of the nonpomeron Regge trajectory can be predicted by using the relation between α_R and the coupling constant. (LBS)

19690 CONSTRUCTION OF AN EMPIRICAL MULTIPLICITY DISTRIBUTION FROM THE FOLDING OF GEOMETRY WITH A SIMPLE DYNAMICS. Barshay, S. (Univ. of Copenhagen). Lett. Nuovo Cim.; 7: No. 14, 671-675(4 Aug 1973).

A simple explicit model for discussing in geometric terms the multiplicity distribution for n particles produced in an inelastic collision of two nucleons is considered. Thus an attempt is made to generalize the classical formula which relates an elastic differential cross section to the impact parameter. (JFP)

19691 HELICITY-AMPLITUDE DESCRIPTION OF LOW-ENERGY NUCLEON-NUCLEON SCATTERING. Kawasaki, M. (Hiroshima Univ.); Yonezawa, M.; Watari, W. Progr. Theor. Phys. (Kyoto); 49: No. 2, 531-540(Feb 1973).

The s-channel helicity amplitudes for t-channel isospin eigenstates are constructed in the elastic region from phenomenological nucleon-nucleon potentials. The features of the resulting amplitudes are discussed in connection with high-energy amplitudes. Effects of the differences of short-range forces in the potentials are examined. (auth)

19692 THREE-NUCLEON PROBLEM AT HIGH ENERGY: ENERGY DEPENDENCE OF BACKWARD p-d ELASTIC SCATTERING BELOW 1 GeV. Bouchez, R.; Jungerman, J. (Univ., Grenoble, France). Ann. Phys. (Paris); 7: No. 6, 443-448 (Nov 1972).

A review is made of the experimental and theoretical situations concerning the backward elastic scattering of protons by deuterons in the 25-500 MeV region. Empirical evidence is shown for a new process beginning at about 300 MeV, which must be added to ordinary nucleon exchange. It appears that experimental data in this energy region can be fitted quite well with a model which employs the isospin 3/2 nucleon resonance at 1,236 MeV in an intermediate state of the three nucleon system. The presence of a N^* ($I = {}^1/_2$) resonance in the ground state of the deuteron is therefore not necessary. The intermediate state model for the three nucleon system involves a three-body force. (FR)

19693 APPROXIMATELY NORMAL MODEL FOR CHARGED PAIR PRODUCTION: A RECONSIDERATION. Kaiser, G. D. (Daresbury Nuclear Physics Lab., Eng.). Nucl. Phys.; B58: No. 2, 541-556(1973).

It is shown that the approximately normal model for the probability P(j) that j charged pairs will be produced in a proton-proton collision ($P(j) = \exp(-[j-m]^2/2\sigma^2)/\Sigma$, where m and σ are energy dependent parameters and Σ is a normalization factor) agrees with experimental results in the range of lab momentum from 5 to 300 GeV/c provided that the elastic amplitude is modified by the presence of a "diffractive" mechanism. Predictions are presented for c.m. energies accessible at the ISR. (auth)

19694 NON-ELASTIC PROCESSES IN DEUTERON-DEUTERON COLLISIONS AT HIGH ENERGIES. Berezhnoi, Yu. A.; Vinokurov, L. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 18: No. 4, 529-534(Apr 1973). (In Russian).

Elastic scattering, splitting of deuterons and a reaction of nucleon transfer in the deuteron-deuteron collisions are considered on the basis of a multiple scattering model. Differential cross sections of deuteron splitting, nucleon transfer and integral cross sections of different processes of deuteron-deuteron interaction were calculated at $P_{lab} = 4.42$ GeV/c. (auth)

19695 NEUTRON POLARIZABILITY AND THE TWO-NEUTRON SCATTERING LENGTH. Arnold, L. G. (Ohio, State Univ., Columbus). Phys. Lett.; 44B: No. 5, 401-404(28 May 1973).

It is shown that the neutron elastic polarizability contribution to the two-neutron scattering length is not negligible if the polarizability is as large as available measurements indicate. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 20200 and 20201.

19696 (RLO-1388-657) SYMMETRY VIOLATIONS. Henley, E. M. (Washington Univ., Seattle. Dept. of Physics). 1973. 40p. (CONF-730642-6). Dep. NTIS $4.25.

From fifth international conference on high-energy physics and nuclear structure; Uppsala, Sweden (18 Jun 1973).

The present experimental and theoretical status of some inexact symmetries is reviewed. Starting with hadronic interactions, which break SU(3), the presentation passes through the electromagnetic interactions which break isospin and possibly time reversal invariance. The discussion ends with the weak interactions and related symmetries, namely those associated with the weak currents and with parity, primarily in hadronic systems. Experiments that can shed further light on the symmetry-breaking effects are suggested. (auth)

19697 TENSOR METHODS IN THE REPRESENTATION OF SU(2). Ivey, G. E. Gainesville, FL; Univ. of Florida (1972). 53p. University Microfilms Order No. 73-15,579.

Thesis (Ph. D.).

The Lie group SU(2), the two by two unitary matrices with determinant one, was originally used in quantum physics as a representation of the rotation group. Calculation of SU(2) and higher order representations of the rotation group give information about operators which are invariant under rotations. More recently, SU(2), SU(3) and other groups have been used in the theory of elementary particles. Products of irreducible representations of the rotation group are not, in general, irreducible. They can, however, be written as a sum of irreducible representations. In this case, eigenfunctions of the angular momentum operators corresponding to the product representation can be written as a sum of eigenfunctions of the angular momentum operators corresponding to the irreducible representations with coefficients called the Clebsch-Gordon coefficients. A simpler representation is constructed, and a method of evaluating the Clebsch-Gordon coefficients more direct than the usual one is given. The rotation group and its usual matrix representation, SU(2) is defined. An isomorphism is constructed from the rotation group to SU(2) by assigning to each rotation a matrix which affects the basis vectors in a three-dimensional vector space in the same ways as the rotation affects the coordinate axes. In addition, the Lie algebra SU(2) associated with SU(2) is defined and its relationship with the rotation group is given. Attention is concentrated on SU(2). A representation of SU(2) in terms of tensors is given. The basic representation consists of dyadics defined on U_2, the two-dimensional unitary space. Irreducible representations of higher order consist of operators on symmetric tensors from the tensor products of U_2 with itself. Products of irreducible representations are given by operators on tensors which are symmetric only under certain interchanges of indices. In this representation, it is possible to construct the eigenfunctions of those operators corresponding to angular momentum operators. In the fourth, they are, in fact, constructed in such a way as to form an orthonormal basis for the representation spaces. In this manner, evaluating the Clebsch-Gordon coefficients becomes simply a matter of calculating the normalizing factors for the eigenfunctions. (Diss. Abstr. Int., B)

19698 SUBGROUP REDUCTIONS OF THE LORENTZ GROUP. Kalnins, E. G. London, Ont.; Univ. of Western Ontario (1972). National Library of Canada, Ottawa.

Thesis (Ph. D.).

Some new properties of the subgroup reductions of the Lorentz group are examined. In particular some new explicit Lorentz invariant expansions are given for scalar functions defined on real and imaginary Lobachevski space in three dimensions. These expansions are given in coordinate systems which correspond to subgroup reductions of the Lorentz group. Of particular interest are the expansions on imaginary Lobachevski space where the calculation of the normalized discrete spectrum expansion formulas give new completeness relations between known special functions. In addition to the expansions on real and imaginary Lobachevski space some subgroup reductions on the manifolds $x_0^2 + x_1^2 + x_2^2 + x_3^2 = 1$ and $x_0^2 - x_1^2 - x_2^2 + x_3^2 = 1$ with proper invariance groups SO(4) and SO(2,2) respectively were examined. The explicit reduction of the principal series of the Lorentz group and the action of the Lie algebra generators in the corresponding basis are given for the four azimuthally symmetric coordinate reductions. The expansion of a function with discrete helicity on the light cone is also given in these coordinate systems. These expansions are used to calculate the mixed basis matrix elements between these four coordinate systems. The infinitesimal is used to calculate recurrence relations for the SO(3) ⟷ SO(2,1), SO(3) ⟷ E(2), and SO(3) ⟷ C mixed basis matrix elements. These relations are then used to derive invariant expansion of solutions of the Proca, Dirac and Pauli-Fierz equations inside and outside the light cone. The nonrelativistic limit of these solutions is also examined. (Diss. Abstr. Int., B)

19699 LONG RANGE FORCES AND BROKEN SYMMETRIES. Dirac, P. A. M. (Florida State Univ., Tallahassee). Proc. Roy. Soc. (London), Ser. A; 333: No. 1595, 403-418(26 Jun 1973).

There are reasons for believing that the gravitational constant varies with time. Such a variation would force one to modify Einstein's theory of gravitation. It is proposed that the modification should consist in the revival of Weyl's geometry, in which lengths are nonintegrable when carried around closed loops, the lack of integrability being connected with the electromagnetic field. A new action principle is set up, much simpler than Weyl's, but requiring a scalar field function to describe the gravitational field, in addition to the $g_{\mu\nu}$. The vacuum field equations are worked out and also the equations of motion for a particle. An important feature of Weyl's geometry is that it leads to a breaking of the C and T symmetries, with no breaking of P or of CT. The breaking does not show itself up with the simpler kinds of charged particles, but requires a more complicated kind of term in the action integral for the particle. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 19623 and 20026.

19700 (IC-72/7) LIGHT-CONE COMMUTATORS, PION AMPLITUDES AND Kl_3 DECAY. Furlan, G.; Paver, N. (International Centre for Theoretical Physics, Trieste (Italy)). Mar 1972. 24p. INIS.

Starting from SU(3) ⊗ SU(3) light-cone commutators, a sum rule is derived for Kl_3 decay. The dispersive path in the plane of the independent scalar variables is a straight line depending, essentially, on m_π, m_K. The SU(3) and SU(2) ⊗ SU(2) symmetry limits, corresponding to the fixed mass configuration, are discussed. (auth)

19701 (IC-72/22) PC NONLEPTONIC HYPERON DECAYS. Kaushal, V. S. (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1972. 5p. INIS.

Parity conserving nonleptonic hyperon decays were investigated in the pole approximation including the contributions from the octet, decuplet and singlet of baryon states as well as from the octet of meson states. The divergence of the seventh component of the vector current is taken as the pc weak Hamiltonian. By comparing with the experimental values of the decay amplitudes, the d/f ratio for the strong vertex is determined. The value thus obtained agrees reasonably well with other quoted results. (auth)

19702 CP-VIOLATION IN THE RENORMALIZABLE THEORY OF WEAK INTERACTION. Kobayashi, M.; Maskawa, T. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 2, 652-657(Feb 1973).

In a framework of the renormalizable theory of weak interaction, problems of CP-violation are studied. It is concluded that no realistic models of CP-violation exist in the quartet scheme without introducing any other new fields. Some possible models of CP-violation are also discussed. (auth)

19703 PARTIALLY CONSERVED AXIAL-VECTOR CURRENT EXTRAPOLATION PROBLEM IN HIGHLY VIRTUAL PHOTON-INDUCED REACTIONS. Chanda, R. (Department of Mathematical Physics, University College, Dublin 4, Ireland); Sen, S. Phys. Rev. D 7: No. 11, 3456-3461 (1 June 1973).

The problem of soft-pion extrapolation in highly virtual photon-induced reactions is investigated by using the "parabola method" of Fubini and Furlan. Also, we point out that the e^+-e^- colliding-beam experiments indicate the hadronic decay width of the intermediate vector boson ($\Gamma_W{}^h$) to be comparable with the leptonic mode ($\Gamma_W{}^l$): $\Gamma_W{}^h/\Gamma_W{}^l \simeq 1$. (auth)

19704 HIGH-ENERGY THEOREMS AND STRUCTURE OF SU(3) ⊗SU(3)-SYMMETRY BREAKING. Noga, Milan (Department of Theoretical Physics, Faculty of Natural Sciences, Comenius University, Bratislava 16, Czechoslovakia). Phys. Rev. D 7: No. 10, 3050-3058 (15 May 1973).

Consequences of Weinberg's postulative assumption requiring that

rapidly growing pole terms which contribute to the forward-scattering amplitude must cancel among themselves and not with the continuum in order to preserve the Regge behavior are examined within the framework of dispersion relations. Twice-subtracted dispersion relations with soft-meson theorems as known subtraction constants are used to determine the transformation properties of the SU(3) ⊗SU(3)-symmetry-breaking term in the mass spectrum of hadrons. (auth)

19705 INFINITE-RANGE INTERACTIONS AND LORENTZ COVARIANCE. Cooke, James H. (Department of Physics, The University of Texas at Arlington, Arlington, Texas 76010). Phys. Rev. D 7: No. 10, 2818-2824 (15 May 1973).

Long-range interactions, such as electromagnetism and gravitation, lead to exchanges of angular momentum and other observables which may persist indefinitely after scattering. These exchanges modify the Lorentz transformation properties of observables associated with the particles coming out of a scattering event. In particular, if the scattering occurs in the presence of a momentum-analyzing magnet of strength ea^{-2}, one can expect failures of covariance in spin and momentum of order $(r_{el}/a)^2\beta^{-3}$, where r_{el} is the classical electron radius and β is the relative velocity of the scattering particles. Without the external field we find linear momentum, helicity, and charge transform properly but total angular momentum (probably not directly measurable) does not. This last result is connected with the infrared catastrophe. (auth)

19706 NEW RELATIVISTIC COULOMB HAMILTONIAN WITH O(4) SYMMETRY AND A SPINOR REALIZATION OF THE DYNAMICAL GROUP O (4,2). Barut, A. O.; Bornzin, G. L. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev. D 7: No. 10, 3018-3024 (15 May 1973).

The Dirac-Coulomb Hamiltonian with a simple modification of the scalar potential corresponding to switching off the interaction of the "small components" is solved by a new "squaring" procedure and is shown to describe a system possessing O(4) symmetry. The new realization of the generators of the corresponding O(4,2) dynamical group shows a nontrivial but natural mixing of the space and spin coordinates in which the total angular momentum replaces the usual orbital angular momentum. (auth)

Applications (Strong)

19707 (CNRS-CPT-73-P-521) ABOUT THE NONRELATIVISTIC STRUCTURE OF THE CONFORMAL ALGEBRA. Burdet, G.; Perrin, M.; Sorba, P. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Feb 1973. 9p. Dep. NTIS (U. S. Sales Only) $3.00.

A new basis of the conformal algebra is proposed, which involves two conjugated Schroedinger algebras. This basis exhibits a chain which does not contain the Poincare algebra, between the SO(4,2) algebra and the (two-dimensional) extended Galilean algebra. This nonrelativistic structure of the conformal algebra is well adapted to discuss some extreme models of hadrons based on collinear massless particles. (auth)

19708 SYMMETRY BREAKING OF CHIRAL U(3) × U(3) AND $X \rightarrow \eta\pi\pi$ DECAY AMPLITUDE. Kobayashi, M. (Kyoto Univ.); Maskawa, T.; Kondo, H. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 2, 634-639(Feb 1973).

The singlet-octet mixing of ps-mesons is discussed based on chiral U(3) ⊗ U(3) symmetry under the assumption that the breaking of chiral SU(3) ⊗ SU(3) symmetry belongs to a $(3,3^*)\oplus(3^*,3)$ representation. The width of $X \rightarrow \eta\pi\pi$ decay is calculated for two models on the breaking of U(3) ⊗ U(3) by using the observed momentum dependence. It is also pointed out that the momentum dependence of the amplitude disappears in the symmetry limit of SU(3) up to second order in the momentum. (auth)

19709 COMPLETE SOLUTIONS FOR A MODEL WITH CHIRAL DYNAMICS. Charap, J. M. (Queen Mary Coll., London). J. Phys., A (London); 6: No. 7, 987-998(Jul 1973).

A mechanical analog for the chiral SU(2) × SU(2) invariant field theory for massless pions has as its classical Lagrangian $L = \frac{1}{2}\dot{q}^i g_{ij}\dot{q}^j$. The coordinates q^i parametrize a manifold (in fact a three-sphere) on which $dq^i g_{ij} dq^j$ is the SU(2) × SU(2) invariant metric. The classical equations of motion are for uniform geodesic motion, and in the corresponding quantum mechanical case the Schroedinger equation is the Laplace-Beltrami-Poisson equation. Both sets of equations are solved completely with attention paid to the conserved quantities, that is, the generators of the invariance group SU(2) × SU(2). The passage to the limiting case, in which the manifold becomes flat, is also described. (auth)

Scattering Theory

Refer also to abstracts 19469 and 19650.

19710 (RLO-1388-655) POMERON COUPLINGS. Brower, R. C.; Weis, J. H. (Washington Univ., Seattle. Dept. of Physics). 1973. 24p. (CONF-730339-1). Dep. NTIS $3.25.

From symposium on the Pomeron; Argonne, Illinois, USA (1 Mar 1973).

The decoupling theorems for the idealized case of a simple isolated factorized Pomeron pole with $\alpha_P(0) = 1$ is reviewed. Then the relevance these results have for more realistic models is discussed. It is argued that s-channel unitary conditions of the type investigated place strong constraints on certain types of diffractive behavior independent of the detailed Pomeron fine structure, that is, the detailed nature of the J plane singularity near J = 1 or equivalently the powers of logarithms of energy in amplitudes. (JFP)

19711 ASPECTS OF THE BOUND-STATE PROBLEM. Townsend, J. S. Baltimore; Johns Hopkins Univ. (1973). 172p. University Microfilms Order No. 73-16,665.

Thesis (Ph. D.).

The eigenvalues of the Wick equation in the weak-binding limit are found in perturbation theory employing two different approaches: a covariant approach using a spectral representation for the Bethe-Salpeter wave function and quantization in the infinite-momentum frame using the technique of Kogut and Soper. The eigenvalues agree to order $\alpha^3 \ln\alpha$. Also the spectral function method is applied to the Schrödinger equation with a Coulomb potential. A simple spectral representation for the momentum-space wave functions is obtained in the form of a contour integral. Both the bound-state and the scattering solutions are evaluated as residues at the poles enclosed by this contour. In addition, the Bethe-Salpeter equation for a fermion-antifermion system coupled by photons is considered. As an interaction kernel the one-photon exchange in the Feynman gauge is retained. Through the application of charge conjugation, parity and Lorentz invariance, the usual sixteen coupled equations are reduced to as few as three, and no more than five, equations for the scalar structure functions describing the various eigenstates. Using the Coulomb interaction, it is demonstrated how these equations can serve as the basis for a systematic perturbation theory. (Diss. Abstr. Int., B)

19712 MINIMAL 3-TO-3 SCATTERING AMPLITUDES. Kowalski, K. L. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. D 7: No. 10, 2957-2960 (15 May 1973).

A relativistic K-matrix formalism is developed for a special class of elastic 3-to-3 amplitudes for which all 2-to-3 transitions are forbidden. The three-pion system and the isospin-3/2 state of three nucleons below the five-pion and pion production thresholds, respectively, are examples of this class. The primary result is a set of connected-kernel on-shell two-particle amplitudes as input. The latter model as well as the general formalism may provide a useful phenomenological framework for evaluating experimental results such as three-pion resonance formation. (auth)

19713 MULTIPARTICLE PARTIAL-WAVE AMPLITUDES AND INELASTIC UNITARITY. II. ANALYSIS OF THREE-BODY UNITARITY. Klink, William H. (Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52240). Phys. Rev. D 7: No. 10, 2980-2989 (15 May 1973).

The three-body unitarity equations are analyzed and it is shown that the partial-wave amplitude for three reacting particles almost fixes the form of the partial-wave amplitude for two reacting particles and the production partial-wave amplitude. Further, it is shown that unitarity imposes constraints on the form taken by the three-body partial-wave amplitude. A program is suggested for utilizing these ideas. (auth)

19714 MULTIPARTICLE PARTIAL-WAVE AMPLITUDES AND INELASTIC UNITARITY. III. SOLUTION OF THE THREE-BODY UNITARITY EQUATIONS USING CHARACTERISTIC OPERATOR FUNCTIONS. Klink, William H. (Department of Physics and Astromony, The University of Iowa, Iowa City, Iowa 52240). Phys. Rev. D 7: No. 10, 2989-2997 (15 May 1973).

The most general solution to the unitarity equations involving $2 \rightarrow 2$, $2 \rightarrow 3$, and $3 \rightarrow 3$ processes is given when the total (including all disconnected processes) $3 \rightarrow 3$ partial-wave amplitude S is non-normal. The solution is given in terms of characteristic operator functions, using the theory of completely nonunitary operators. It is shown, once the characteristic operator function is given, how to compute the $2 \rightarrow 3$ partial-wave amplitude. An appendix shows that, if S can be exponentiated and all forces are two-body forces, no particle production is allowed, i.e., the $2 \rightarrow 3$ partial-wave amplitude is zero. (auth)

19715 LIGHT-CONE SINGULARITIES AND ASYMPTOTIC DOMAINS OF MOMENTUM SPACE. Vinciarelli, Patrizio; Weisz, Peter (Center for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. D 7: No. 10, 3091-3104 (15 May 1973).

We present and discuss the formalism of the Mellin-transformed Deser-Gilbert-Sudarshan representations and apply it to the study of asymptotic behaviors of forward scattering amplitudes. (auth)

19716 DERIVATION OF THE MITRA THREE-BODY MODEL FROM THE FADDEEV THEORY. Vanzani, V. (Univ., Padua). Nuovo Cim.; 16A: No. 3, 449-461(1 Aug 1973).

The Mitra three-body model is reformulated in the context of the Faddeev theory. A mathematical relationship between the Mitra spectator functions and the Faddeev scattering wave function components, in the separable potential approximation, is established. Some questions related to the interpretation of the Mitra formalism in terms of generalized optical wave functions are discussed and some new insight into the problems involved in the distorted-wave description of direct nuclear reactions is obtained. (auth)

19717 INTEGRAL EQUATION METHOD FOR THE ANALYTIC CONTINUATION OF THE S-MATRIX. Minelli, T. A.; Vitturi, A. (Univ., Padua). Nuovo Cim.; 16A: No. 3, 462-472(1 Aug 1973).

It is shown here that the Fredholm method can be generalized to the solution of an integral equation relating the analytic continuation of the Bloch Green's function at different energies; by this equation the analytic continuation of the S-matrix for cut-off potentials can be obtained. The analytical properties of the Fredholm determinant of our problem are pointed out, and the equivalent of the Jost and Pais relation is deduced. (auth)

19718 TWO-CURRENT PLANAR AMPLITUDES IN THE DUAL RESONANCE MODEL. Fidler, R. W. (Cambridge Univ., Eng.). Nucl. Phys.; B58: No. 2, 525-540(1973).

In the framework of the dual resonance mode, two-current planar amplitudes are constructed by a procedure suggested by Cremmer, Neveu and Scherk. In particular, the large-s behavior of the Compton-like amplitudes is considered. Besides normal Regge trajectories, half-slope trajectories are found which are shifted by an amount depending on the momenta of the current legs. Additionally, a j = 1 wrong-signature fixed-pole behavior is found, but no right-signature fixed poles are present. The scaling limit is also discussed, and found to depend critically on certain ill-defined factors arising in the model. (auth)

19719 UNITARY SUM RULES FOR AMPLITUDES INVOLVING SPACELIKE REGGEONS AND SINGULARITIES IN PAIRS OF COMPLEX HELICITY VARIABLES. Mak, S. Y. (Brown Univ., Providence). Nucl. Phys.; B58: No. 2, 598-620(1973).

Unitary sum rules for amplitudes involving two space-like reggeons are derived. These sum rules are then shown to be equivalent to the physical unitary equations of reggeon amplitudes. To define these amplitudes properly, the "triple" O(2,1) partial-wave expansion of a six- and an eight-particle amplitude is studied in detail. Forty-eight pairs of helicity singularities are found, of which twelve pairs are allowed to contribute simultaneously in the physical limit of interest. The pair, at $\mu_2 = \alpha_2$, $\mu_3 = \alpha_3$, is shown to be the "leading" contributing pair for various physical reasons. Reggeon/particle scattering amplitudes involving two spacelike reggeons are defined as the residue of multiparticle amplitudes at this leading pair. Possible applications of unitary sum rules are discussed. In particular, their relevance for the understanding of the Deck phenomenon is pointed out. (auth)

19720 ANALYTIC CONTINUATION OF SCATTERING AMPLITUDE IN SCATTERING ANGLE USING IMPACT-PARAMETER EXPANSION. Bhatt, S. C. (Univ. of Alberta, Edmonton). Nuovo Cim.; 16A: No. 2, 277-289(21 Jul 1973).

An analytic continuation of the scattering amplitude in the complex $y = \sin(\theta/2)$, θ being the scattering angle is derived, using the impact-parameter expansion of the scattering amplitude as proposed by Adachi and Kotani. Following Creekmore's method, an integro-differential equation for the scattering amplitude is derived. This integro-differential equation is solved and an integral equation is obtained which enables the desired analytic continuation to be obtained. Similar results for scattering of particles with spin are also derived. (auth)

19721 RELATION BETWEEN VARIATIONAL METHODS IN SCATTERING THEORY. Singh, S. R. (York Univ., Downsview, Ont.). Lett. Nuovo Cim.; 17: No. 12, 493-497(21 Jul 1973).

It is shown that a variational method used to obtain the phase function for the scattering of a nonrelativistic particle from a center of force is related to the Kohn–Hulten method. Some consequences of this relation are discussed. (LBS)

19722 ANALYTIC PROPERTIES OF THE IMPACT PARAMETER AMPLITUDE. Obara, T. (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 49: No. 2, 586-593(Feb 1973).

Analytic properties of the impact parameter amplitude H(s,b) are discussed in the b-plane. It is shown that H(s,b) has algebraic branch points at b = 0 and their orders depend on the Regge trajectory, if the amplitude is expressed by the Regge pole. As an example a detailed discussion is given for the Veneziano amplitude. It is also stressed that the s-plane analyticity of H(s,b) is much simpler than that of the partial wave amplitude. (auth)

19723 SCATTERING BY SINGULAR POTENTIALS. Baeteman, M. L. Brussels; Univ. of Brussels (1973). vp. (In Dutch). Centre d'Etude de l'Energie Nucleaire, Mol, Belg.

Thesis.

A general method is developed for the determination of the phase shift for particle scattering by a repulsive singular potential. This potential is represented on a Riemann surface by a Laurent series involving a finite number of negative powers. The method gives direct formula for the phase shift and also permits the determination of the behavior at low as well as high energies. Also numerical methods are given for the calculation of the regular solution. One can also treat the case of singular attractive potentials by a formula extension of the theory for average complex potentials. It is shown that these potentials behave as absorbing wells. (JFP)

19724 EXPANSION OF THE SCATTERING MATRIX IN A POWER SERIES IN THE MOMENTUM AND ITS ANALYTICAL CONTINUATION. Minelli, A.; Vitturi, A.; Zardi, F. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 52: No. 5, 734-737(May 1972). (In Italian).

In the case of scattering processes for cutoff potentials the energy and momentum power expansion of the scattering matrix is considered; the Hadamard method is then used in order to find the affixes of the resonance poles. The basic tool used is the introduction of a modified Green's function and of a Fredholm integral equation correlating this function at two different energies. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

19725 DENSITY DEPENDENCE OF THE HEAT CAPACITY ANOMALY IN LIQUID ^{4}He NEAR THE LAMBDA TRANSITION. McCoy, T. H. Stony Brook, NY; State Univ. of New York (1973). 98p. University Microfilms Order No. 73-15,909.

Thesis (Ph. D.).

In order to provide more information on the thermodynamics of the lambda transition in liquid helium, a series of precision measurements of the temperature variation of the constant volume heat capacity C_V of liquid He^4 near the lambda point were performed in samples covering the complete density range between the saturated vapor and freezing pressures. A sealed bomb method was used. It was found that, for He II, the C_v data have a temperature dependence that is close to logarithmic at all densities; while for He I, C_v is close to logarithmic only at the lowest densities and obeys finite power laws at higher densities. Comparisons with the results of other workers are made. (Diss. Abstr. Int., B)

19726 CRITICAL LIGHT SCATTERING IN ^{4}He NEAR THE GAS-LIQUID CRITICAL POINT. Kagoshima, S.; Ohbayashi, K; Ikushima, A. (Tokyo Univ.). J. Low Temp. Phys.; 11: No. 5/6, 765-774(Jun 1973).

Scattered intensities of light were measured near the gas–liquid critical point of ^{4}He at scattering angles of 30, 60, and 90° as functions of the reduced temperature $\epsilon = |T-T_c|/T_c$ along the critical isochore ($T > T_c$) and the coexistence curve ($T < T_c$). The temperature range was $3 \times 10^{-5} < \epsilon < 1.5 \times 10^{-2}$. Critical exponents and coefficients describing divergence of the generalized susceptibility χ and the correlation length ξ are obtained as $\gamma(T > T_c) = 1.31 \pm 0.02$, $\nu(T > T_c) = 0.66 \pm 0.02$, $\xi_0(T > T_c) = 4.2 \pm 0.6$ Å, $\gamma'(T < T_c) = 1.32 \pm 0.02$, $\nu'(T < T_c) = 0.68 \pm 0.02$, $\xi_{\pm}(T < T_c) = 2.6 \pm 0.7$ Å, $\eta = 0.06 \pm 0.06 (T > T_c)$, $0.05 \pm 0.05 (T < T_c)$, and $\chi_0(T > T_c)/\chi_0(T < T_c) = 3.6 \pm 0.4$. It is pointed out that the quantal nature of ^{4}He has remarkable influence on the critical behavior of ^{4}He in the above-mentioned temperature region. (auth)

19727 DYNAMICS NEAR THE TRICRITICAL POINT OF A ^{3}He–^{4}He MIXTURE. Grover, M. K. (Brown Univ., Providence, RI); Swift, J. J. Low Temp. Phys.; 11: No. 5/6, 751-756(Jun 1973).

By means of mode–mode coupling, damping constants were computed near the tricritical point of a ^{3}He–^{4}He mixture. Both on the coexistence curve and in the tricritical region mass diffusion constant $\approx |T-T_t|^{+\frac{1}{2}}$, thermal diffusion constant $DK_T \sim |T-T_t|^{-\frac{1}{2}}$, and third viscosity $\sim |T-T_t|^{-\frac{1}{2}}$ are found, where T is the temperature and T_t is the tricritical temperature. These results imply that damping constant of second sound $\sim |T-T_t|^{-\frac{1}{2}}$ in the ordered phase. (auth)

19728 DENSITY CORRELATION FUNCTION IN SUPERFLUID HELIUM NEAR T_λ. Hohenberg, P. C. (Bell Telephone Labs., Murray Hill, NJ). J. Low Temp. Phys.; 11: No. 5/6, 745-750(Jun 1973).

The previously calculated hydrodynamic form of the density correlation function of liquid helium is written out explicitly for T near T_λ. This function, which is proportional to the intensity of light scattered from the fluid, has a finite value at $\omega = 0$, which grows as $T \to T_\lambda$ from below. In evaluating the precise form of this contribution in terms of transport coefficients, it is important to keep terms of order $(C_p/C_v)-1$. (auth)

19729 PHASE TRANSITION IN BOSE LIQUID. 1. Kanno, S. (Ibaraki Univ., Mito, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 6, 2210-2236(Dec 1972).

It is shown that the Bose liquid can be worked out in a way similar to the Landau Fermi liquid theory by decomposing the diagonal elements of the Boltzmann factor for the system into irreducible diagrams. The energy of the system is expressed by the functional of the occupation number n_p. The excitation energy is defined by the variation of the energy with respect to n_p. The Landau f-functions (the second variations of the energy) are closely related to the excitation energy and play important roles in the phase transition. The excitation-energy dependence of Landau f-functions are obtained for the dilute gas. (auth)

19730 ROTON–ROTON INTERACTIONS IN SUPERFLUID HELIUM. 2. Nagai, K. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 1, 46-63(Jan 1973).

For the purpose of studying the roton–roton interaction in superfluid helium, the temperature variation of the self energy of the roton is calculated by use of the self-consistent T-matrix approximation. The results were compared with the data of the inelastic neutron scattering experiments. The structure of the T-matrix is determined by the coupling constant and the single roton energy width. The major contribution to the self energy comes from the scattering channels with attractive coupling. For a strong attractive coupling, two-roton resonance states occur and the self energy shows an anomalous temperature dependence far from the experiments. Therefore, attractive coupling constants are required to be weak in order to reproduce the simple nature of the temperature variation of the observed energy shift. A comment is given on the two-roton spectra of the inelastic neutron scattering. (auth)

19731 THERMAL CONDUCTIVITY OF A SUPERLEAK IN THE RANGE 0.06 to 1 K. Haasbroek, J. N. (Kammerlingh Onnes Laboratorium, Leiden). Cryogenics; 13: No. 6, 373-375 (Jun 1973).

The thermal conductivity of a superleak consisting of a stainless steel tube filled with a very fine powder is made up of three factors. Firstly the conductivity of the stainless steel tube given by $\lambda_{ss} = aT + bT^2$, secondly the contribution due to the pressed powder and finally, when the superleak is filled with He^4, thermal excitations in the fluid may contribute as well. Considering these contributions it is shown that the thermal transport in a superleak at low temperature should be determined by the linear term in the conductivity of the stainless steel tube. However anomalous behavior may occur and thus the thermal conductivity of such a superleak was measured down to 0.06 K by a stationary method in a cryostat using both liquid He^3 and demagnetization for cooling. It was shown that the equation already given for the conductivity of the stainless steel is correct down to 60 mK, the linear term agreeing within the accuracy of measurement with the electrical resistance using Wiedemann-Franz's law. For $T < 0.1$ K the conductivity of a superleak shows an increase compared to the value derived from Wiedemann-Franz's law. Filling the superleak with superfluid He^4 increases the thermal transport for $T > 0.3$ K, about 10% at the highest temperature but at low temperatures ($0.06 < T < 0.3$ K) the He^4 does not give rise to a measurable additional thermal transport. It is concluded that the superfluid does not give rise to appreciable heat transport in the low temperature region down to 0.06 K and for $T < 0.1$ K the powder gives rise to an additional thermal transport which is comparable to the transport of non-crystalline solids. (UK)

19732 THERMODYNAMIC ANALYSIS OF THE LAMBDA-TRANSITION IN LIQUID HELIUM. Borelius, G. (Kungliga Tekniska Hoegskolan, Stockholm). Phys. Scr.; 7: No. 1-2, 75-79 (1973).

A thermodynamic analysis of the thermal properties of liquid helium leads to the conclusion that in the temperature range near to the λ-point the liquid is a microscopic mixture of two solutions, one of small aggregates of He I in He II and the other of small aggregates of He II in He I. (auth)

19733 DISPERSION OF TRANSVERSE ZERO SOUND IN LIQUID HELIUM-3. Lea, M. J.; Birks, A. R.; Lee, P. M.; Dobbs, E. R. (Univ. of Lancaster, Eng.). J. Phys., C (London); 6: No. 11, L226-L230(11 Jun 1973).

The dispersion relation for transverse sound in a Fermi liquid has been derived for all $\omega\tau$ (ω is the sound frequency, τ is the quasi-particle relaxation time), and using this the shear wave properties of liquid ^{3}He have been calculated. For $\omega\tau < 1$ the dispersion relation should behave classically, but at low temperatures and high frequencies ($\omega\tau \gg 1$) transverse zero sound should propagate if the liquid is pressurized. The nature and properties of this zero sound are discussed, and suggestions are offered as to how it could be studied experimentally. (auth)

19734 EFFECTS OF A WEAK INTERMEDIATE-RANGE ATTRACTION ON THE LOW-MOMENTUM PART OF THE PHONON DISPERSION CURVE IN He II. Iachello, F. (Istituto di Fisica del Politecnico, Turin); Rasetti, M. Lett. Nuovo Cim.; 7: No. 8, 295-299(23 Jun 1973).

The results of a study of the effects of an intermediate-range attraction in the two-body potential are presented. This attraction is present in the phenomenological interaction. The study is made in the framework of the Brueckner–Sawada theory of a dense Bose gas. Because of the limitations of such theory, the numerical results are to be considered as having only a semi-quantitative character. (MHR)

19735 SCALING LAWS AND THE SPECIFIC HEAT OF BOSE LIQUID. Kanno, S. (Ibaraki Univ., Mito, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1410-1411(Oct 1972).

19736 PHASE TRANSITION IN BOSE LIQUID. II. Kanno, S. (Ibaraki Univ., Mito, Japan). Progr. Theor. Phys. (Kyoto); 49: No. 2, 401-415(Feb 1973).

The method proposed in a previous paper is applied to the calculation of thermodynamical functions. This method resembles the Landau Fermi liquid theory in the sense that the energy, excitation energy, etc., are expressed by the functionals of occupation numbers of quasi-particles. It is shown that if the excitation energy of a quasi-particle ϵ_p is proportional to p^r with $2 > r > 3/2$, then the specific heat c_p behaves as $\log(T_c/|T - T_c|)$. The thermal behavior of condensation density is discussed also. It is shown that the fluctuation of condensation density becomes infinite on the transition line. (auth)

19737 SCALING LAWS AND CRITICAL EXPONENTS OF CONDENSED BOSE LIQUID. Kanno, S. (Ibaraki Univ., Mito, Japan). Progr. Theor. Phys. (Kyoto); 49: No. 2, 416-423(Feb 1973).

The relations among the critical exponents of condensed Bose liquid are obtained under the assumption of the scaling property for the mean occupation number of particles. Some of these relations are inequalities and may violate the scaling relations of Widom and Kadanoff. This violation is caused by two factors. One is the breakdown of the homogeneity of the one-particle density matrix and the other is the nonvanishing condensation density contributing to the total density. The fluctuation of the condensation density is also discussed in connection with the scaling property. (auth)

19738 NONUNIFORM STATES OF LIQUID HELIUM. Bowley, R. M. (Univ. of Nottingham, Eng.). J. Low Temp. Phys.; 11: No. 5/6, 777-785(Jun 1973).

Nishiyama's theory of liquid helium was generalized to systems where the density is nonuniform. By a series of transformations the Hamiltonian can be diagonalized, the excitation energies being given by the eigenvalues of a pair of coupled differential equations. The theory is then used to discuss vortices, vapor–liquid surfaces, and impurities in nonuniform systems of helium. (auth)

Superconductivity

Refer also to abstracts 18751, 18765, 18791, 18820, and 18826.

19739 (AD-757875) MICROWAVE SURFACE RESISTANCE OF TYPE II SUPERCONDUCTORS IN THE VORTEX STATE. Report for December 1970–January 1972. Pedersen, R. J.; Kim, Y. B.; Thompson, R. S. (Aerospace Corp., El Segundo, Calif.). 19 Mar 1973. Contract F04701-72-C-0073. 41p. (SAMSO-TR-73-108). NTIS.

The microwave surface resistance of various Nb–Ta and Pb–In superconducting alloys were measured using a derivative technique to determine its rate of change with field near H (C2). Previous dc measurements of this slope have generally been interpreted to show agreement with the Caroli–Maki theory, which Thompson has found to be incomplete. The measurements show a region of constant slope somewhat below H (C2) with a magnitude in agreement with the dc results but also show that the slope increases rapidly to approach the Thompson values in the limit H approaches H (C2). Theoretical arguments are presented indicating why the two theories can have different regions of validity. (auth)

19740 ELECTRON THERMAL CONDUCTIVITY OF SUPERCONDUCTING FILMS OF INDIUM–GADOLINIUM AND LEAD–GADOLINIUM ALLOYS. Mrstik, B. J.; Ginsberg, D. M. (Department of Physics and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). Phys. Rev. B 7: No. 11, 4844-4850 (1 June 1973).

We have measured the thermal conductivity of quench-condensed superconducting lead and indium films containing small amounts of gadolinium. The data are in good agreement with the theory of Ambegaokar and Griffin and of Bennemann (modified for strong-coupling effects), except at the lowest temperatures, where problems in the interpretation of the data cause deviations. We have found that strong-coupling effects do not entirely account for the discrepancy between weak-coupling theory and the data of Bjerkaas et al. for the thermal conductivity of quench-condensed films of indium containing small amounts of manganese. Thus, our results support evidence from tunneling and high-frequency electromagnetic experiments that the properties of superconductors with rare-earth impurities are understood, but those with transitions-element impurities are not. (auth)

19741 UPPER CRITICAL FIELD AND THE DENSITY OF STATES IN AMORPHOUS STRONG-COUPLING SUPERCONDUCTORS. Bergmann, G. (Institut für Festkörperforschung der Kernforschungsanlage Jülich, Jülich, Germany). Phys. Rev. B 7: No. 11, 4850-4860 (1 June 1973).

The upper critical field of the amorphous superconductors $Bi_{0.85}Tl_{0.15}$, Ga, $Sn_{0.86}Cu_{0.14}$, and $Pb_{0.75}Bi_{0.25}$ is measured in the temperature range from 1.5 °K to the zero-field transition temperature. Films of the amorphous metals about 1500 Å thick are obtained by quenched condensation onto a substrate at He temperature. The initial slopes of the $B_{c2}(T)$ curves are used to determine the electronic density of states at the Fermi surface. For all the investigated materials these values were enhanced compared with the density of states which one obtains from the free electron model. For Ga, $Sn_{0.86}Cu_{0.14}$, and $Pb_{0.75}Bi_{0.25}$ the experimental enhancement factor agrees well with the electron–phonon enhancement factor $1+\lambda$, where λ is taken from superconducting–tunneling experiments. The temperature dependence of B_{c2} deviates from that predicted by Werthamer, Helfand, and Hohenberg, showing B_{c2} values too large in the low-temperature region. It is suggested that the strong-coupling behavior of the amorphous superconductors is responsible for the deviation at low temperature. (auth)

19742 RESPONSE OF A SUPERCONDUCTOR TO A STATIC, SPATIALLY DEPENDENT PERTURBATION OF THE INTERACTION CONSTANT. Jacobs, A. E. (Univ. of Toronto). J. Low Temp. Phys.; 11: No. 5/6, 623-638(Jun 1973).

The proximity effect between two materials with slightly different interaction constants is considered. A perturbation expansion of the Gor'kov equations and the self-consistency equation is employed to derive self-consistent results for the Green functions and the order parameter, the expansion parameter being the difference of the interaction constants. A similar expansion of Eilenberger's equations is used to generalize these results to the impure case. The first-order perturbation to the order parameter is analyzed, and its asymptotic behavior is obtained. (auth)

19743 THEORY OF VORTEX MOTION IN AN INHOMOGENEOUS SUPERCONDUCTING FILM. Schmid, A.; Hauger, W. (Univ., Dortmund, Ger.). J. Low Temp. Phys.; 11: No. 5/6, 667-685(Jun 1973).

A phenomenological theory is presented giving an account of the pinning effect which occurs when vortex motion in a superconducting film is hindered by inhomogeneities of the material. In particular, the theory incorporates the interaction (pinning) potential between a vortex and the material defects as well as long wavelength distortion of the vortex lattice. A recent observation of quantum interference effects of a moving vortex lattice can be explained successfully. It is shown how the pinning potential and the elastic constants can be obtained from experiment. (auth)

19744 INVESTIGATION OF ENERGY-GAP ANISOTROPY IN SUPERCONDUCTING ALUMINUM, CADMIUM, AND ZINC. Cheeke, J. D. N.; Ducla-Soares, E. (CNRS, Grenoble, France). J. Low Temp. Phys.; 11: No. 5/6, 687-714(Jun 1973).

Measurements of the low-temperature specific heat of the pure metal and dilute nonmagnetic alloys of Al, Cd, and Zn are described. The washing out of the energy gap anisotropy with increasing impurity as predicted by Anderson was observed in aluminum–magnesium alloys, and the mean-squared anisotropy parameter $\langle a^2 \rangle$ was measured to be $\langle a^2 \rangle \simeq 0.010$. Values deduced from measurement on Zn and Cd and their corresponding alloys with $l \leq \xi_0$ gave $\langle a^2 \rangle \simeq 0.02$ for Zn and $\langle a^2 \rangle \simeq 0.05$ for Cd. Values of the gaps determined by fitting to a two-gap model are given and compared to those deduced from previous work. (auth)

19745 SUPERCONDUCTING FLUCTUATIONS, PAIR BREAKING, AND NUCLEAR RELAXATION IN SMALL PARTICLES. Simanek, E.; Imbro, D.; MacLaughlin, D. E. (Univ. of California, Riverside). J. Low Temp. Phys.; 11: No. 5/6, 787-802(Jun 1973).

A theoretical treatment of the combined effects of superconducting fluctuations and pair breaking on nuclear spin-lattice relaxation in small particles is described, in which the interaction of normal-state electrons with both fluctuations and impurities (i.e., renormalization of fermion propagators and impurity vertex corrections) is taken into account. The calculation is valid in the dirty limit and near the superconducting transition temperature, and exhibits qualitative agreement with presently available experimental results. (auth)

19746 HIGH-TEMPERATURE SUPERCONDUCTIVITY IN THE Li–Ti–O TERNARY SYSTEM. Johnston, D. C. (Univ. of California, San Diego, La Jolla); Prakash, H.; Zachariasen, W. H.; Viswanathan, R. Mater. Res. Bull.; 8: No. 7, 777-784 (Jul 1973).

The first high temperature superconducting oxide compound is reported. The compound is $Li_{1+x}Ti_{2-x}O_4$ has the face-centered cubic spinel structure, with $a_0 \cong 8.40$Å. The transition temperatures of this compound range from ~ 7°K to 13.7°K. (auth)

19747 ULTRASONIC ATTENUATION IN SUPERCONDUCTING MOLYBDENUM. O'Hara, S. G. Lubbock, TX; Texas Tech Univ. (1972). 118p. University Microfilms Order No. 73-16,279.

Thesis (Ph. D.).

Measurements have been made of the ultrasonic attenuation of 10, 30, and 50 megahertz longitudinal sound waves in normal and superconducting high purity molybdenum single crystals. These measurements were made for ultrasound propagated in the [100], [110], and [111] crystallographic directions of molybdenum. The attenuation was measured as a function of the temperature from 1.10 to 0.38 Kelvin using a "single-shot" type ^{3}He refrigerator. The data were taken with the aid of an ultrasonic transmitter-receiver system employing a sampling integrator and phase detection. This system greatly improved the signal to noise ratio in the detection of ultrasonic echoes. The measured ultrasonic attenuation was analyzed in terms of the Bardeen, Cooper, Schrieffer (BCS) theory of superconductivity. Good agreement has been found with the predictions of this theory for attenuation in the [100] and [111] directions in molybdenum. Data for the [100] direction indicated some deviation from a BCS single energy gap model. These deviations were found to arise primarily from the attenuation in the superconducting state for this orientation at temperatures near the superconducting transition temperature. Data for both the [100] and [111] directions give anomalously low values for the BCS energy gap at the lowest ultrasonic frequency of 10 megahertz. This frequency dependence has been correlated with measured values of the phonon–wavevector–electron mean free path product (ql) for the particular molybdenum specimens studied. The values of ql were measured directly using magnetoacoustic techniques. The frequency dependence of the energy gap has been identified as that predicted by Leibowitz for low values of ql. The value of the energy gap determined for each orientation at the highest ultrasonic frequency was taken to be the frequency independent energy gap, $2\Delta(0)$, of the BCS model. This energy gap has been found to be anisotropic. Values of the energy gap for the various orientations were found. (Diss. Abstr. Int., B)

19748 HYPERSONIC ATTENUATION IN SUPERCONDUCTORS. Lue, J. W. Pittsburgh; Univ. of Pittsburgh (1972). 71p. University Microfilms Order No. 73-16,341.

Thesis (Ph. D.).

The effect of nonzero reduced phonon energy, $\hbar\omega/2\Delta(0)$, on longitudinal hypersound attenuation was studied in superconducting aluminum and cadmium at frequencies of 9.2 to 9.3 GHz. Evidence of the quasi-particle creation process contribution (in addition to the usual quasi-particle scattering) is given by the characteristic temperature variation. A fairly sharp discontinuity and a steep but continuous attenuation are observed in the case of aluminum and cadmium, respectively. Both the discontinuity temperature in aluminum and the highest temperature of the steep variation interval in cadmium are significantly below T_c (4 mK in the former case and 10 mK in the latter one). Based on the BCS calculation, the attenuation data of aluminum have been satisfactorily analyzed by a single energy gap [$2\Delta(0) = (3.6 \pm 0.1) k_B T_c$], while that of cadmium has to be fitted by assuming a continuously varying energy gap [$2\Delta(0) = (2.48-3.66) k_B T_c$] along the effective zone on the Fermi surface. In addition, a similar measurement on the ultrasonic attenuation in vanadium was made. No distinctive small s-gap effects were observed, as might have been expected from specific heat measurements. (Diss. Abstr. Int., B)

19749 MACROSCOPIC QUANTUM PHENOMENA FROM PAIRING IN SUPERCONDUCTORS. Schrieffer, J. R. (Pennsylvania Univ., Philadelphia). Phys. Today; 26: No. 7, 23-28 (Jul 1973).

The history of the development of the theory of superconductivity is sketched briefly. Emphasis is placed on paired electron states which lead to large-scale effects in superconductivity. (MHR)

19750 TUNNELING IN SUPERCONDUCTING INDIUM UNDER PRESSURE. Nedellec, P.; Noer, R. J. (Paris Univ., Orsay, France). Solid State Commun.; 13: No. 1, 89-91(1 Jul 1973).

The transition temperature, energy gap, and phonon energies in superconducting indium have been measured at pressures up to 16.7 kbar by electron tunneling through Schottky barriers. (auth)

19751 RESISTANCE JUMP IN THE PURE TYPE-1 SUPERCONDUCTORS TIN, INDIUM, AND LEAD. Freud, R. (Danmarks Tekniske Hoejskole, Lyngby). Solid State Commun.; 13: No. 1, 121-123(1 Jul 1973).

It is shown that for tin, indium and lead samples of sufficiently high purity, sufficiently large diameter (2 to 3 mm), and sufficiently close to the critical temperature ($\Delta T < 0.15$K), there exists a common value close to $2/3$ ($0.64 \leq R(i_c)/R_n \leq 0.69$) of the resistance jump at the transition from the superconducting to the intermediate state. (auth)

19752 UPPER CRITICAL FIELDS OF SUPERCONDUCTING Gd AND Tm DOPED $LaSn_3$. Effects of Crystalline Electric Fields. Guertin, R. P. (Tufts Univ., Medford, MA); Crow, J. E.; Sweedler, A. R.; Foner, S. Solid State Commun.; 13: No. 1, 25-29(1 Jul 1973).

The temperature dependence of the upper critical fields, $H_{c_2}(T)$, is presented for $(La_{1-x}Gd_x)Sn_3$ and $(La_{1-x}Tm_x)Sn_3$. For samples with nearly the same T_c, $H_{c_2}(T)$ of the Tm-doped $LaSn_3$ samples are always larger than those for the Gd-doped samples. The results are interpreted in terms of crystalline electric field splitting of magnetic levels of the Tm^{3+}. Pure $LaSn_3$ is found to be a Type I superconductor. (auth)

19753 SUPERCONDUCTIVITY AT HIGH TEMPERATURES. Matthias, B. (Univ. of California, La Jolla, San Diego). Recherche (Paris); 4: No. 33, 319-326(Apr 1973). (In French).

Up until recent times, high temperature superconductivity has not been a very promising field. It is shown that the theory of Bardeen, Cooper and Schrieffer, which explains very well the theory of superconductivity, does not enable the temperature beneath which a material becomes superconducting to be determined and in fact has not aided research workers towards a solution of this problem. The recent discovery of ternary compounds is encouraging in view of developing materials having high critical temperatures. (FR)

19754 SUPERCONDUCTIVITY OF CADMIUM–MAGNESIUM ALLOYS. Claeson, T.; Munkby, L.; Wingbro, T. (Chalmers Tekniska Hoegskola, Goteborg). Phys. Scr.; 7: No. 1-2, 80-83 (1973).

The superconducting transition temperatures, T_c, have been measured for several Cd–Mg compositions. T_c decreases rapidly with increasing Mg content, and is already at 50 at.% Mg less than 30 mK. No relevant change in T_c could be detected as samples were either quenched from above the ordering temperature of an intermediate ordered alloy or annealed below that temperature. (auth)

19755 MAGNETIC NUCLEATION FIELDS FOR A SUPERCONDUCTOR IN CONTACT WITH A NORMAL METAL. Martinoli, P. (Laboratoire de Physique, Zurich). Phys. Kondens. Mater.; 16: No. 1, 53-93(1973).

A theoretical and experimental investigation of the magnetic nucleation fields is presented for a superconductor in contact with a normal metal (proximity effect). The calculations are based on the de Gennes–Werthamer approximation for the pair potential $\Delta(r)$ and on a relation from which one obtains the critical fields of an inhomogeneous superconducting system if $\Delta(r)$ and T_c (the transition temperature of the system) are known. Near a second order phase transition, the results are valid in the dirty limit and over the whole temperature range. The experiments deal with the parallel ($H_{c||}$) and perpendicular ($H_{c\perp}$) critical fields of Cu/Pb double layers as a function of the temperature and thickness of the Pb-film. Although the conditions for the dirty limit are not fulfilled by the specimens, it is possible to obtain a satisfactory description of $H_{c||}$ and $H_{c\perp}$ by a suitable interpretation of the coherence lengths. From the measurements an attractive electron–electron interaction g_n for copper is deduced. It is found that $g_n = +0.08 \pm 0.02$ from T_c and $g_n = +0.04 \pm 0.02$ from $H_{c\perp}$. (auth)

19756 ANGULAR DEPENDENCE OF Nb_3Sn CRITICAL CURRENTS IN TRANSVERSE MAGNETIC FIELDS. Jergel, M.; Takacs, S.; Cabelka, D.; Cernusko, V.; Kruzliak, J. (Electrotechnical Inst., Bratislava). Czech. J. Phys.; 23: 644-651 (1973).

The dependence of critical currents of vapor-deposited and diffusion-processed Nb_3Sn tapes on the magnitude and direction of magnetic field perpendicular to the current is experimentally investigated. By comparing the experimental results with theoretical considerations it is concluded that the form of grains in the vapor-deposited samples is almost sinusoidal, whereas for the diffusion-processed ones it is more ellipsoidal. For both kinds of tapes, detailed structural microanalysis (electron microscopy, scanning electron microscopy, optical microscopy) of the substrate and the Nb_3Sn tapes has been performed in order to explain the existence and the character of the above mentioned dependences from the processes of the grain formation. (auth)

19757 IS THE EFFECT OF V_3Au SUPERCONDUCTOR ELECTRONIC OR PHONONIC? Junod, A.; Bellon, P.; Fluekiger, R.; Heiniger, F.; Muller, J. Phys. Kondens. Mater.; 15: No. 2, 133-141(1972). (In French).

Specific heat measurements from 1 to 40°K give some insight into the phonon spectrum of the alloy V_3Au. The minute differences between the as-cast and annealed states indicate that the drastic change of the superconducting transition temperature upon ordering is not likely to be of phononic origin. Alternatively, this behavior can be understood as a consequence of an electronic density-of-states change in the presence of a large Coulomb pseudopotential term. This assumption is supported by susceptibility measurements. (Metals Abstr.)

19758 OBSERVATION OF A CHANGE IN SIGN OF THE ENTROPY FLUX ASSOCIATED WITH THE MOTION OF VORTICES IN A TYPE II SUPERCONDUCTOR HAVING A SMALL KAPPA VALUE. Vidal, F. (Ecole Normale Superieure, Paris). Compt. Rend., Ser. B; 276: No. 15, 661-664(9 Apr 1973). (In French).

A change in the sign of the entropy flux associated with the motion of vortices in a type-II superconductor (Pb – 4.56% at. In) having a small value for its Ginzburg – Landau parameter (kappa approximately 1.25) was observed in the H_{c1} region. In order to explain this effect, the existence of vortices of opposite sign is proposed. (FR)

19759 LOW-FREQUENCY INTERNAL FRICTION IN NIOBIUM AT NORMAL AND SUPERCONDUCTIVE STATES. Gindin, I. A.; Starodubov, Ya. D.; Okovit, V. S. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 18: No. 4, 667-670(Apr 1973). (In Russian).

The amplitude dependence of the internal friction in Nb in the normal and superconductive states was observed at a frequency of 0.5 Hz. The internal friction of deformed and annealed polycrystalline Nb wire 1.5 mm in diameter was measured at 1.5 to 4.2°K. The decrement of damping was independent of the amplitude, but the much higher internal friction in comparison with a background in the amplitude region of 2 to 4×10^{-5} could not be explained. (KSW)

19760 SUPERCONDUCTIVITY OF THE BERYLLIDES OF SOME TRANSITION METALS. Matyushenko, N. N.; Matsakova, A. A.; Pugachev, N. S. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 18: No. 4, 672-675 (Apr 1973). (In Russian).

Beryllides of Mo, W, Nb, Ta, and Rh were prepared and used in the measurements of electrical resistance ($R_{4.2°K}/R_{300°K}$) and lattice parameters in powder x-ray diffraction studies. $MoBe_{22}$ and WBe_{22} exhibited critical temperatures which agreed with the observations of other workers; the other beryllides did not display superconductivity down to 1.7°K. (KSW)

19761 MICROSCOPIC QUANTUM INTERFERENCE IN THE THEORY OF SUPERCONDUCTIVITY. Cooper, L. N. (Brown Univ., Providence, RI). Phys. Today; 26: No. 7, 31-39(Jul 1973).

An outline of some of the main features of the 1957 BCS theory, an indication of directions taken since, and a discussion of quantum interference effects due to the single-spin pairing in superconductors are presented. (MHR)

19762 ELECTRON – PHOTON INTERACTIONS AND SUPERCONDUCTIVITY. Bardeen, J. (Univ. of Illinois, Urbana). Phys. Today; 26: No. 7, 41-45; 47(Jul 1973).

The development of the role of electron – phonon interactions in superconductivity is discussed from its beginnings in 1950 up to the present, both before and after the development of the microscopic theory in 1957. The self energy and pair potential, and thus the Green's functions, can be derived either empirically from tunneling data or directly from microscopic theory with use of the Eliashberg equations. (MHR)

19763 STUDY OF DIFFUSION IN THIN Cu/Pb FILMS USING AUGER ELECTRON SPECTROSCOPY. Wilson, J. M. (Cambridge Univ., Eng.). Phil. Mag.; 27: No. 6, 1467-1474(Jun 1973).

Diffusion in thin bimetallic films of Cu and Pb used in superconductivity work has been evaluated by Auger electron spectroscopy. Measurements at the original Cu surface show that after diffusion the final surface composition is predominantly Pb with some Cu, suggesting that the original interface may have broken up during diffusion. An Arrhenius plot gives an activation energy of 0.52 ± 0.07 eV for the process. The technique appears to be a new method of measuring diffusion rates in thin films. (auth)

19764 PHASE TRANSFORMATIONS IN SUPERCONDUCTING ALLOYS OF NIOBIUM – TITANIUM – ZIRCONIUM SYSTEM. Kadykova, G. N. Tr. Mosk. Inst. Elektron. Mashinostr.; No. 22, 10-20 (1972). (In Russian).

Metallographic, dilatometric, and x-ray analyses and hardness and resistivity measurements were used to study transformations occurring in superconducting Ti alloys, containing Nb 35 to 65% with small amounts of Zr, during heating and low temperature isothermal annealing of cold-deformed alloys. Drawing was carried out with intermediate annealing at 700°C (Nb 35%) or 580°C (Nb 50 to 65%). The breakdown kinetics of the β solid solution and the formation of ω and α phases are discussed. (Metals Abstr.)

19765 FABRICATION AND STUDY OF A V-CRYSTAL IN SUPERCONDUCTING NIOBIUM. Thorel, P.; Kahn, R.; Simon, Y.; Cribier, D. (CEN de Saclay, Gif-sur Yvette, France). J. Phys. (Paris); 34: No. 5, 447-452(May 1973). (In French).

The formation conditions for a vortex monocrystal in niobium were studied using neutron diffraction. It was shown that in niobium an anisotropy axis perpendicular to the flux lines exists as far as the superconducting properties are concerned and that consequently the V-lattice forms a single crystal of low mosaicity over the entire volume. The quality of the V-crystal, measured in terms of the width of the rocking curve, depends on the following factors: relative orientation of the anisotropy axis and the faces parallel to the external magnetic field, previous magnetic history, value of the magnetic field H_0, value of the critical current. When a direct current is applied in any direction perpendicular to H_0 the rocking curve varies with the different regions of the V – I characteristics. In the same sample submitted to an alternating current, no broadening of the rocking curve appears and the V-crystal obtained is better than for the dc current. (FR)

19766 WIRE STRUCTURE OF THE 35BT SUPERCONDUCTING ALLOY. Titov, V. S.; Pashkov, P. P.; Fridman, A. A.; Granovskii, E. B.; Fedotov, L. N. Tr. Vses. Nauch.-Issled. Inst. Elektromekh.; 35: 119-124(1971). (In Russian).

The structural conversion of samples of the superconducting alloy 35 BT (Ti – 35% Nb – 7% Zr) was studied after different regimes of thermal treatment. Samples were annealed at 450, 500, and 550°C, and then held an 0.5 or 2 hr at the desired temperatures. An ω-phase existed in the cold-worked state, being formed during the process of drawing the wire. This phase dissolved during annealing at 450°C for 0.5 hr; after 2 hr a δ-phase appeared. Annealing at 500°C dissolved the δ-phase, leading to the appearance of a superstructure. Annealing at 550°C was accompanied by recrystallization; periods in excess of 2 hr lead to twinning. (tr-auth)

19767 INFLUENCE OF FERMI SURFACE TOPOLOGY ON THE PRESSURE DEPENDENCE OF T_c FOR INDIUM AND DILUTE INDIUM ALLOYS. Smith, T. F. (Univ. of California, San Diego, La Jolla). J. Low Temp. Phys.; 11: No. 5/6, 581-601(Jun 1973).

The pressure dependence of the superconducting transition temperature for In, In – Cd (to 3.5 at. %), and In – Pb (to 12 at. %) was determined to 24 kbar. A small deviation from a linear dependence of T_c on volume compression is found for indium. Alloying with Cd and Pb modified this nonlinear contribution, which is interpreted as arising from changes in the Fermi surface topology. In all, four transitions are identified and their possible origins, based upon the known Fermi surface of indium, are discussed. (auth)

Equipment and Devices

Refer also to abstracts 18405, 18945–18948, 18992–18999, 19055, and 19095.

19768 (LA-tr-73-13) COIL CHARACTERISTICS OF WIRE WITH EXTREMELY THIN TWISTED CORE STRINGS. Ikeda, C.; Furuto, Y.; Inoue, I.; Suzuki, T. Translation of Kyokusai Tashin Tsuisuto Sen no Koiru Tokusei. 3p. Dep. NTIS $3.00.

A comparison between coil characteristics of a superconducting magnet with an untwisted wire core and a magnet with a twisted wire core was made with the aim of developing a standard magnet of about 60 kG magnetic field strength and with an effective inside diameter of about 2.5 cm. It was concluded that using a wire with twisted cores, coil current can be set high, high speed excitation (2.2 kG/A) is possible, and reproducibility is good. Quality deterioration by breaking and constriction of core filaments expected in the twisting process was hardly noticed. (MHR)

19769 (LA-tr-73-14) ON CONNECTION CURRENT OF COMPOSITE SUPER CONDUCTIVE WIRE. Furuto, Y.; Ikeda, C.; Meguro, S.; Inoue, I. Translated from pp 266 of Conference of the Institute of Electrical Engineers of Japan, 1973. 4p. Dep. NTIS.

In order to study the effect of twisting of a wire with extremely thin twisted core filaments, a type of two current model, which regards the current inside superconductors as an overlap of superelectrons and normal electrons, was adopted. A critical state model for superelectrons and a viscosity current model for normal

electrons are set up and the fundamental equations are established. (MHR)

19770 (LA-tr-73-15) PRODUCTION OF V_3Ga SUPERCONDUCTIVE MAGNET (1). Furuto, Y.; Ikeda, C.; Tanaki, Y.; Suzuki, T.; Meguro, S. I.; Inoue, I. Translation of V_3Ga Choadendo Magunetto no Shisaku (1). 3p. Dep. NTIS $3.00.

A magnet was produced using V_3Ga wire and its use as a winding for high magnetic field magnets was examined. The results of the V_3Ga coil test are shown. Based on these results a 160 kG magnet is under design and production; its dimensions are shown. (MHR)

19771 (LA-UR-73-391) COMPRESSIVE LOAD-DEFLECTION CHARACTERISTICS OF SEVERAL MATERIALS AT ROOM TEMPERATURE, 77°K and 4.2°K. Stewart, W. F.; Eash, D. T.; May, W. A. (Los Alamos Scientific Lab., N. Mex.). 1972. Contract W-7405-eng-36. 20p. (CONF-730805-5). Dep. NTIS $3.00.

The compressive load-deflection characteristics of several flexible foam materials and a low density rigid styrofoam were determined at room temperature, 77°K and 4.2°K. A flexible foam is used to avoid highly localized loading of the cryostat inner shell by the lateral support system of a superconducting coil experimental model of a pulsed plasma thermonuclear fusion energy source. The flexible foam materials that were tested became extremely rigid at the lower temperatures, but returned to their original flexible condition upon warming to room temperature. The compressive load-deflection characteristics of the materials tested are presented. (auth)

19772 SUPERCONDUCTING ELECTRICAL MACHINE ROTORS. Wood, M. B. (to International Research and Development Co. Ltd.). British Patent 1,316,173. 9 May 1973. Filed Date 31 Mar 1970. 3p.

The rotor described comprises a cylindrical assembly of flat coils of varying width lying in chordal planes of the assembly, each coil being composed of superconducting material wound around an insulating former. The individual coils are electrically insulated from one another, and the coils are bound together by layers of insulating material. The formers for the coils can be of reinforced synthetic resin, preferably using woven glass fibre sheet as the reinforcement, and the layers of insulating material binding the coils together can be resin-bonded carbon fibres. Such rotors are suitable for the superconducting electrical machine described in BP 1315302. (UK)

19773 USE OF SUPERCONDUCTORS TO PROVIDE FIXED POINTS ON A CRYOGENIC TEMPERATURE SCALE. Schooley, J. F.; Soulen, R. J. Jr. (National Bureau of Standards, Washington, DC). pp 169-174 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 1. Preston-Thomas, H. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P1).

It is suggested that reproducible superconductive transition temperatures be used as fixed points for temperature scales below 10K. The superconductive transitions of lead, indium, aluminum, zinc, and cadmium have been found to be as narrow as one millikelvin and reproducible to less than one millikelvin. It is planned that devices incorporating these elements will be made available through the NBS Office of Standard Reference Materials. (auth)

19774 RESISTANCE THERMOMETRY WITH THIN SUPERCONDUCTING ALUMINUM FILMS. Liebenberg, D. H.; Allen, L. D. F. (Los Alamos Scientific Lab., NM). pp 875-883 of Temperature: Its measurement and Control in Science and Industry. Vol. 4, Pt. 2. Rubin, L. G. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P2).

Thin aluminum films operated within their resistive superconducting transition were calibrated as thermometers using the T_{58} vapor pressure scale for helium. The stability of the films to successive temperature cycles and to ambient air exposure was measured to be better than ±3 mK. Films with sensitivities from 10^2 to 10^5 Ω/K were evaporated onto glass substrates and granular aluminum films were produced to increase the normal film resistance. Temperature differences of 10 μK were measured using a four wire potentiometer technique. A relative temperature calibration for small temperature changes was obtained by using an electronic temperature controller to introduce temperature steps. In addition this technique permitted the smoothness of the resistive transition to be measured. The dependence of probe current on the measured resistance was determined throughout the temperature range of the superconducting transition. From measured film dimensions current densities of 50 A cm^{-2} were used in a typical measurement although the films were observed to support current densities of greater than 10^4 A cm^{-2}. (auth)

19775 MAGNETIC THERMOMETRY USING A SUPERCONDUCTOR. Ries, R. P.; Mapother, D. E. (Univ. of Illinois, Urbana). pp 885-895 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 2. Rubin, L. G. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P2).

Compared with other available low temperature thermometers, a superconducting element offers the advantages of stability and high reproducibility under repeated cool-downs. A thermometer using high purity aluminum as the superconducting element has been tested over its useful range, 0.3 to 1.2 K. An ac induction method detects the superconducting transition with a sensitivity of about 0.1 mK. Temperature is derived from the dc current to a small superconducting solenoid which initiates the transition. The complete thermometer (aluminum element, detection coils, and driving solenoid) fits within a 6 mm cylinder and is easily mounted in good thermal contact with the measured system. Preliminary measurements indicate an absolute accuracy better than ±0.5 mK to be obtainable. In addition to providing a local standard for calibrating less stable secondary thermometers, the unit seems suitable for use as a transfer standard for comparing low temperature scales at different laboratories. (auth)

19776 SUPERCONDUCTING TUNNEL JUNCTION THERMOMETRY. Bakker, J. W.; Van Kempen, H.; Wyder, P. (Katholieke Univ., Nijmegen, Netherlands). pp 1097-1102 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 2. Rubin, L. G. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P2).

It is well known that the current-voltage characteristics of superconductor/insulator/normal-metal junctions can be described by the Bardeen-Cooper-Schrieffer theory. The feasibility of using such junctions as primary thermometers was studied. The junctions, $Al/Al_2O_3/Ag$, are deposited onto ruby which is cooled down by adiabatic demagnetization. The current (I) versus voltage (V) curves and the derivative (dV/dI) were measured at V = 0. The temperatures are determined by comparison of the measured curves with computer generated curves. The results are compared with the temperature indicated by calibrated resistance thermometers. It is shown that the junctions can be used as primary thermometers with a reasonable absolute accuracy, a very high resolution and a power dissipation which can be of the order of 10^{-12} W. (auth)

19777 APPLICATION OF NUCLEAR ORIENTATION TO ULTRALOW TEMPERATURE THERMOMETRY. Steyert, W. A. (Los Alamos Scientific Lab., NM). pp 1253-1257 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 2. Rubin, L. G. (ed.). Pittsburgh; Instrument Society of America (1972).

From fifth symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P2).

When radioactive nuclei are cooled in an appropriate environment, their radioactive decay products tend to be emitted in preferred directions. This anisotropy of emission may be accurately related to the temperature through the basic theory of angular momentum and through precise NMR studies of the nucleus in this same chemical or metallurgical environment. One of the most convenient and well-studied nuclear orientation primary thermometers is the angular distribution of the 0.835 MeV γ-rays emitted by ^{54}Mn in a polarized iron foil. The nature of the ^{54}Mn decay scheme frees the anisotropy from any nuclear structure effects. If care is taken in foil preparation, the temperature is directly related to the anisotropy through the accurately measured hyperfine energy. The comparatively short nuclear relaxation time allows rapid temperature measurement. While this thermometer is simple to use with minimal instrumentation, it requires a minimum of about 0.08 T field on the foil to polarize the iron. For cases where it is necessary to avoid this large field, some other self-polarizing single crystal orientation thermometers are possible. Experiments intercomparing orientation thermometers are discussed. (auth)

19778 THERMOMETRY BELOW 0.1K: A COMPARISON OF THE MOESSBAUER EFFECT THERMOMETER AND THE γ-RAY ANISOTROPY THERMOMETER. Taylor, R. D. (Los Alamos Scientific Lab., NM). pp 1259-1265 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 2. Rubin, L. G. (ed.). Pittsburgh; Instrument Society of America (1972).

From 5th symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P2).

Temperature measurements have been derived from Moessbauer effect measurements of ^{57}Co in Fe and from γ-ray anisotropy measurements of ^{57}Co, ^{60}Co, and ^{54}Mn in Fe at dilution refrigerator temperatures of about 25 mK. Satisfactory temperature agreement lends credence concerning the adequacy of the theories used. The Moessbauer effect thermometer requires no calibration and gives absolute temperatures (T) from measurements of intensity ratios at that T; the one studied here is of most practical use over the range 10 to 500 mK. The ground state splitting of ^{57}Co in Fe has been measured by the method of nuclear magnetic resonance destruction of oriented nuclei; a value of 294.8 ± 0.2 MHz was determined for T ~ 0 K and zero applied field. The ground state moment of ^{57}Co is 4.76 ± 0.01 nm. The mixing ratio $\delta = +0.124 \pm 0.001$ for the 122.1 keV γ ray of the ^{57}Co decay was determined by comparing the 122 keV anisotropy W(0) with the concomitant 136 keV anisotropy near 25 mK. Calculated Moessbauer effect spectra incorporating these parameters have been reduced to graphical form convenient for deducing temperatures from experimental spectra. (auth)

19779 JOSEPHSON FREQUENCY CONVERSION IN SUPERCONDUCTING POINT-CONTACT JUNCTIONS. Longacre, A. Jr. Rochester, NY; Univ. of Rochester (1973). 121p. University Microfilms Order No. 73-14,823.

Thesis (Ph. D.).

The term "Josephson frequency conversion" refers to a mode of operating the Josephson junction wherein it acts as both the local oscillator and mixer in a form of heterodyne conversion. Both experimental and analytical results arising from the demonstration and study of that frequency-converting property in superconducting point-contact junctions are presented. The main down-conversion experiments involved a dc-biased point-contact junction coupled strongly to a 9.3 GHz (f_c) coaxial cavity and simultaneously irradiated with 24 GHz (f) microwaves. "Sum and difference steps," which appeared at the voltages $h(nf \pm f_c)/2e$ in the junction's V-I curve, were indirect indicators of conversion from nf to f_c. By detecting the fields excited in the cavity when the junction was biased to the first order (n = 1) sum or difference step, Josephson frequency conversion from 24 GHz to 9.3 GHz was directly demonstrated. In similar experiments, indirect evidence was obtained also of down-conversion from 640 GHz to 20 GHz and of up-conversion from 25 GHz to 350 GHz. An analog simulation of the down-conversion experiment, based upon the circuit of a Stewart model junction connected to a series L-C-R resonance, to an ac source and to dc biasing circuitry, has yielded V-I curves in excellent qualitative agreement with the experimental results. Close comparison between the two, however, has revealed a slight zero-bias conductance peak in the point-contact junctions' shunt resistances. Also, the rf-induced behavior of about half the junctions studied failed quantitatively to fit the analog results. Nonetheless, the point-contact junctions seemed well characterized, on the whole, by the Stewart model, and the experimental results were, in all respects, closely reflected in the analog simulation. (Diss. Abstr. Int., B)

19780 METHOD OF FABRICATING A HARD INTERMETALLIC SUPERCONDUCTOR BY MEANS OF DIFFUSION. Suenaga, M.; Sampson, W. B.; Gurinsky, D. H. (To United States Atomic Energy Commission). U. S. Patent 3,731,374. 8 May 1973. Filed Date 20 Jul 1971. 6p.

Method of providing fine superconductors in a metal matrix wherein solid-state diffusion of a selected component from the matrix takes place and is "enhanced" by an externally added component to provide a desired superconductor alloy in the matrix is described. (auth)

19781 HIGH-FREQUENCY LOSSES AND STABILITY OF THE RESONANCE FREQUENCY OF SUPERCONDUCTING CAVITY RESONATORS. Benacka, S. (Elektrotechnicky Ustav SAV, Bratislava). Elektrotech. Cas.; 24: No. 4, 209-216(1973). (In Czech).

An analysis is made of factors, limiting the theoretical presumptions on the quality and resonance frequency of superconducting resonators. The analysis results indicate practical possibilities of obtaining qualities of the order 10^{11} and frequency stability 10^{-11}. (auth)

19782 BEHAVIOR OF A FLUX PUMP USING AN AUTOMATIC SUPERCONDUCTING SWITCH. Carroll, K. J. (Univ. of Oklahoma, Norman). Cryogenics; 13: No. 6, 353-360 (Jun 1973).

A simple kind of magnetic flux pump, consisting of a small superconducting coil L_1 in parallel with a superconducting magnet L_2, has been constructed and tested. The device is attached to the secondary of a transformer and the entire assembly rests in a liquid helium bath. Persistent currents in L_2 are generated by a power supply which can be made particularly simple if an axial magnetic field H_b is applied to L_1 to make its critical current sense-dependent. Circuits analysis shows that the rate of flux pumping is dependent on the magnitude of the power supply output and the final persistent current level is related to H_b. These results are confirmed by experiments in which several circuit parameters were varied. A typical experiment generated 35 A in a small magnet in about 10 minutes. Suggestions are made for improvements on this behavior. (auth)

19783 RESPONSE OF RF SUPERCONDUCTING QUANTUM INTERFEROMETERS, PARTICULARLY THOSE CONTAINING RESISTIVE SECTIONS, TO MAGNETIC FLUX MODULATION. Park, J. G. (Imperial Coll. of Science and Tech., London). J. Phys., F (London); 3: No. 6, 1144-1168(Jun 1973).

The response of a double hole RF SQUID (superconducting quantum interference device) to modulation by magnetic flux ϕ_e introduced into one of the holes is first considered. Care must be taken in defining ϕ_e. The output voltage v_0 is a periodic function of ϕ_e but it is shown that one would expect the period not to be equal to the flux quantum ϕ_0 itself but to some multiple of it. The period depends both upon the ratio of the inductances of the two holes and on the size and shape of the modulation coil, current in which produces ϕ_e. It is pointed out that the flux in either hole of the SQUID may be calculated by imagining the weak link broken and the RF drive removed: one period of the v_0 variation is produced by a change in ϕ_e sufficient to change the flux in either hole (averaged over one RF cycle), due both to current in the coil and to current induced on the inside wall of the SQUID, by ϕ_0. This principle is applied to a double hole SQUID modified by the replacement of part of one wall by a block of normal metal (an R SQUID). Explicit expressions for the response to modulation, which is frequency dependent, are derived in the limit of low frequency, when the skin depth is large in comparison with the thickness of the normal region, and more generally, at any frequency, for an R SQUID in which both the holes and the modulation coil are long in comparison with their diameter. Currents may then be treated as uniformly distributed along their length. The size of the superconducting screen which must surround the R SQUID, if only to avoid interference from other magnetic fields in the laboratory, is shown to play an important part in determining the response at low frequencies. The spectrum of noise currents is also calculated. The results of an experiment on the frequency dependence of the flux modulation response are in good agreement with the calculations. (auth)

19784 TYPE I SUPERCONDUCTING HIGH CURRENT rf JOINT. Yogi, T. (California Inst. of Tech., Pasadena). Cryogenics; 13: No. 6, 369-370(Jun 1973).

For stable operation, high power rf structures, such as transmission lines and resonators fabricated by brazing and welding, must remain superconducting, including joints, at high power levels. In order to study the performance of joints in a copper structure covered with electroplated lead, a half-wave, open-ended 230 MHz coaxial resonator was built. Several types of joints were tested. It was found that direct electroplating of lead on a brazed joint gave poor results but if the brazed joint was overlaid with copper before lead-plating the undesirable effects of the brazing alloy were eliminated. A layer of copper was electroplated by a brush plating technique to a layer of 0.1 mm and with subsequent polishing a uniform substrate for lead plating across the joint was obtained. This high current joint has been used successfully for an inductively loaded 50 MHz resonator up to surface field levels of more than 200 G (2×10^{-2} T) without noticeable Q degradation due to joints. Thus the method provides convenient and economical means of fabricating type I superconducting joints for large rf currents. (UK)

19785 SELECTING THE OPERATING MODE OF SUPERCONDUCTING QUANTUM VOLTMETERS AND MAGNETOMETERS. Gubin, L. P. Meas. Tech. (USSR) (Engl. Trans.); 15: No. 12, 1834-1835(Dec 1972).

Translated from Izmer. Tekh.; 15 No. 12, 56(Dec 1972).

It is shown that with a suitable choice of the value for the transport current passing through a superconducting quantum interferometer it is possible to suppress the low-frequency components of the complex voltage oscillations in interferometers and to restore periodicity to the oscillations. (MHR)

19786 IMPROVED TECHNIQUE FOR MEASURING HYSTERESIS LOSS IN SUPERCONDUCTING MAGNETS. Wilson, M. N. (Rutherford High Energy Lab., Chilton, Eng.). Cryogenics; 13: No. 6, 361-363(Jun 1973).

This technique is based on an XY display of the hysteresis loop of a magnet; the hysteresis loss is proportional to the loop area. It is shown that the shape and area of the loop are simply related

to the short sample properties of the superconductor. Extraneous effects in a magnet can sometimes distort the loop and this enables the technique to be used as a diagnostic tool in magnet testing. (auth)

19787 PERFORMANCE OF THIN FILM SUPERCONDUCTING BOLOMETERS IN MAGNETIC FIELDS. Kimber, R. M.; Rogers, S. J. (Kent Univ., Canterbury, Eng.). Cryogenics; 13: No. 6, 350-351(Jun 1973).

Thin films of pure superconducting metals and alloys can be used as rapid response bolometers over a wide temperature range if a small magnetic field is applied. The characteristics of various films are discussed together with a brief consideration of methods of use. (auth)

19788 OBSERVATION OF ANOMALOUS MICROWAVE IMPEDANCE OF SUPERCONDUCTING POINT JUNCTIONS. Vystavkin, A. N.; Gubankov, V. N.; Kuzmin, L. S.; Likharev, K. K.; Migulin, V. V.; Spitsyn, A. M. (Inst. of Radio Engineering and Electronics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 17: No. 6, 204-206(20 Mar 1973).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Red.; 17: No. 6, 284-288(20 Mar 1973).

It was shown previously that the usual "resistive" model of a superconducting S/C/S junction of small dimensions implies the existence of singularities in its microwave impedance Z at frequencies ω close to the natural Josephson frequency ω_v. If $\omega \gtrsim \omega_v$, the real part of Z can take on negative values. Experimental observation of this effect in superconducting point junctions is reported here. (MHR)

19789 EFFECT OF INTERTURN HEAT FLOW ON THE RECOVERY CURRENTS OF A SUPERCONDUCTING MAGNET: A COMPARISON OF CALCULATED AND MEASURED VALUES. Carter, C. N.; Lewis, K. G.; Maddock, B. J. (Central Electricity Research Labs., Leatherhead, Eng.). Cryogenics; 13: No. 6, 337-343(Jun 1973).

Cryostatic stabilization is appropriate for superconducting magnets producing steady fields over large volumes. The measured recovery currents for a 10 cm bore 6.4 T experimental solenoid are compared with values derived from a stability analysis which includes heat flow from the resistive region to adjacent conductors as well as to the helium coolant. Agreement is excellent despite some uncertainty in the helium heat transfer characteristic and in the thermal conductivity of the interturn insulation. Given good data for these it should be possible, using the method presented, to design cryostatically stabilized windings with precision just from basic data for the conductor and its intended environment. Details of the behavior of large and small resistive regions in this solenoid are given. The critical currents are also accurately predicted from the performance of short samples of the conductor after taking account of anisotropy with respect to the direction of the ambient magnetic field. (auth)

19790 MICROPROCESSING OF SUPERCONDUCTING Nb_3Sn TAPES BY ELECTRON-BEAM MICROETCHING. Jergel, M. (Electrotechnical Inst., Bratislava); Dubravcova, V. Czech. J. Phys.; 23: No. 7, 765-772(1973).

The unsuitable mechanical properties of Nb_3Sn (its brittleness) make the production of a conductor in the required shape and dimensions very difficult. A method has been proposed and experimentally investigated by which the existing superconducting Nb_3Sn tape could be modified to obtain intrinsically stable superconductor. The required filamentation of commercial Nb_3Sn conductor is manageable by electron-beam microetching. The achieved results could serve as a starting point for the construction of a special electron-beam machine. Such device may work in connection with the Nb_3Sn producing apparatus. (auth)

19791 SUPERCONDUCTING MAGNET WITH A DYSPROSIUM MAGNET GUIDE. Gostishchev, V. I.; Drozd, A. A. Dokl. Akad. Nauk BSSR; 17: No. 3, 218-220(Mar 1973). (In Russian).

An electromagnet with a Dy magnet guide has been fabricated and tested. The magnetizing coils were wound with Nb-Ti superconducting wire. A magnetic field of 50 kilooersteds was produced in the 15-mm working gap. The non-uniformity of the transverse magnetic field along the large axis of the pole pieces was less than 1% at a distance ± 10 mm from the center. (tr-auth)

19792 SUPERCONDUCTING ELECTRON LENSES. Septier, A.; Bonjour, P. (Paris Univ., Orsay, France). Phys. Bull. (London); 24: 433-434(Jul 1973).

A problem of weight arises when using a conventional electron magnetic lens in microscopes using electrons accelerated by voltages in the region of 1 to 3.5 MV, due to the cumbersome coil required to obtain a lens convergence within reasonable limits. To overcome this difficulty high field superconducting coils have recently been developed. Characteristics of these coils are discussed. A recently developed superconducting lens with pole pieces made from rare earth metals such as dysprosium and holmium whose magnetization saturation is larger than 3T is described. The pole pieces are classical in shape, the circular coil is enclosed in a thick Co steel yoke and conical pole pieces are used. A systematic experimental and theoretical study has been made to optimize the shape and dimensions of the pole pieces (the pole cutting angle, diameter and thickness), taking into account the low permeability of the material, to obtain a maximum value for the field in the gap while keeping the coil field constant. Measurements have been carried out for various values of the gap width, and various lens geometries (symmetrical and unsymmetrical lenses), to minimize the aperture aberration coefficient Cs. (UK)

19793 SUPERCONDUCTING ELECTRICAL MACHINES. Harrowell, R. V. (Central Electricity Research Labs., Leatherhead, Eng.). Phys. Technol.; 4: No. 1, 80(1973).

It is stated that contrary to most schools of thought the Central Electricity Research Laboratories favours a superconducting alternator with a rotating, rather than a stationary, armature when considering the configuration of large superconducting alternators. It is thought that the difficulties and thus cost involved in this design are no greater than in the alternative. The major objection to the rotating armature machine is the difficulty of collecting, at a phase-phase PD of about 30 kV peak, three rotor currents that are about five times greater than the field current that is transferred at present through two sets of brushes and slip rings at 1 kV. There are two major difficulties with the stationary-armature machine: the transfer of vacuum and liquid helium through rotating seals to the superconducting rotor; and the screening of the surroundings from a strong rotating magnetic field. (UK)

19794 RESISTIVE MEASUREMENTS ON AN IMPROVED Nb–Al–Ge SUPERCONDUCTING RIBBON. Eager, T. W.; Rose, R. M. (Massachusetts Inst. of Tech.; Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS 20: No. 3, 742-743(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

An improved version of the Nb–Al–Ge ribbon has been produced. This ribbon is considerably less porous and more flexible than its predecessor. Resistive measurements at 4.2° to 16°K in steady transverse magnetic fields up to 150 kOe are presented. Preliminary results on other Nb_2Al-based compounds in ribbon form are also presented. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 17949, 19887, 20027, 20133, 20145, 20150, and 20159.

19795 (AD-758449) CORRELATED SAMPLING MONTE CARLO NEUTRON TRANSPORT USING SAMCEP: THREE STUDIES. Beverly, W. B.; Engebretson, A. C. (Ballistic Research Labs., Aberdeen Proving Ground, MD). Feb 1973. 46p. (BRL-1633). NTIS.

Three neutron transport studies in uniform nitrogen have been made using the correlated sampling, Monte Carlo, transport code SAMCEP. They are (1) the scale check problem set, (2) the elastic angular distribution problem set, and (3) the Thomason Perturbation Problem Set. The calculated differences in the radiation field due to the various cross section perturbations either agreed with other calculations where comparison was possible or were self-consistent. An evaluation of the fluence-difference statistic showed that its improvement was appreciable for realistic cross section perturbations. (auth)

19796 (ITEF-921) EFFECTIVE CROSS SECTIONS FOR CALCULATION OF FAST NEUTRON ATTENUATION IN MULTIGROUP APPROXIMATION. Bergel'son, B. R.; Chuprakov, D. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1972. 16p. (In Russian). INIS.

A technique for determining effective cross sections to be used in fast-neutron attenuation calculations in multigroup approximations is explained, and the results from effective cross section computations are presented for six media. A comparison was made with total transport cross sections, extracted cross sections, as used in the NRN method and with experimental data. (6 figures) (tr-auth)

19797 (N-73-18678) ANALYSIS OF TEMPERATURE-DEPENDENT NEUTRON TRANSMISSION AND SELF-INDICATION MEASUREMENTS ON TANTALUM AT 2-keV NEUTRON ENERGY. Semler, T. T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1973. 47p. (NASA-TN-D-7214). NTIS.

The method of pseudo-resonance cross sections is used to analyze published temperature-dependent neutron transmission and self-indication measurements on tantalum in the unresolved region. In the energy region analyzed, 1825.0 to 2017.0 eV, a direct application of the pseudo-resonance approach using a customary average strength function will not provide effective cross sections which fit the measured cross section behavior. Rather a local value of the strength function is required, and a set of resonances which model the measured behavior of the effective cross sections is derived. This derived set of resonance parameters adequately represents the observed resonance behavior in this local energy region. Similar analyses for the measurements in other unresolved energy regions are necessary to obtain local resonance parameters for improved reactor calculations. This study suggests that Doppler coefficients calculated by sampling from grand average statistical distributions over the entire unresolved resonance region can be in error, since significant local variations in the statistical distributions are not taken into consideration. (auth)

19798 (ORNL-TM-3994) MACK: COMPUTER PROGRAM TO CALCULATE NEUTRON ENERGY RELEASE PARAMETERS (FLUENCE-TO-KERMA FACTORS) AND MULTIGROUP NEUTRON REACTION CROSS SECTIONS FROM NUCLEAR DATA IN ENDF FORMAT. Abdou, M. A.; Maynard, C. W.; Wright, R. Q. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 112p. Dep. NTIS $7.75.

A model for calculating neutron energy release parameters (fluence-to-kerma factors) is discussed. The computer program MACK, designed to calculate pointwise neutron fluence-to-kerma factors from nuclear data in ENDF format, is described. MACK calculates the following: pointwise cross sections at an arbitrary energy mesh, cross sections from resonance parameters in the resolved and unresolved resonance regions, energy group cross sections by reaction, pointwise kerma factors, and multigroup kerma factors. The energy point mesh and group structure can be arbitrarily set by the user. Kerma factors and cross sections can be averaged over an arbitrary input weighting function or any of several built-in functions. The kerma factors and cross sections by reaction are of prime importance in calculating heating, dose, and reaction rates of interest in any nuclear system. (4 figures, 23 tables) (auth)

19799 (STI/DOC-10/146) NEUTRON NUCLEAR DATA EVALUATION. Summary of a Panel on Neutron Nuclear Data Evaluation, Vienna, August 30-September 3, 1971. (International Atomic Energy Agency, Vienna (Austria)). Jun 1973. 133p. IAEA $5.00.

The task of the assembled panel was to review the methods, quality, and status of neutron nuclear data evaluation and to examine the basic requirements and problems associated with establishing, maintaining, using, and exchanging computer-based libraries of evaluated neutron data. The panel gave a detailed review of the status and quality of existing major libraries. It compared in detail the main computer formats for evaluated data, and it discussed the role and efficiency of nuclear theory in evaluation. (18 tables) (RWR)

19800 (UNI-35) UNIVAC 1108 HAMMER-HANFORD VERSION SUPPLEMENTARY USERS NOTE. Toffer, H. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 20 Jun 1973. Contract AT(45-1)-1857. 48p. Dep. NTIS $4.50.

The HAMMER SYSTEM was obtained from the Savannah River Laboratories and adapted to the computer facilities in Richland, Washington, in 1967. Since that time, the code has been modified and updated, the cross section libraries have been expanded, and the coding has been altered to be compatible with the computer and software changes at the computational facility in Richland. A description of the code, details of the modifications, and users instructions are contained in DUN-4829. Since the issuance of DUN-4829 in October 1968, further updating of the code has taken place. Currently the HAMMER-HANFORD version is operable on the UNIVAC 1108 computer, using the CSCX Fortran 5 compiler. The intent of the Supplementary Users Note is to describe changes made in the code not described in DUN-4829, provide updated cross section library listings, illustrate the use of different cross section libraries, supply a sample problem with appropriate control cards, and show the control cards required to access the cross section libraries and library processing codes. (RWR)

19801 BASIC THEORY OF THERMAL NEUTRON SCATTERING BY CONDENSED MATTER. Windsor, C. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 1-30 of Chemical Applications of Thermal Neutron Scattering. Willis, B. T. M. (ed.). London; Oxford Univ. Press (1973).

The subject is covered in sections: scattering theory—elastic scattering (scattering from a single nucleus, scattering from many nuclei—coherent and incoherent scattering); nuclear Bragg scattering (powder scattering, single-crystal scattering); scattering theory—inelastic scattering (the eigenstate formulation, the time-dependent formulation, the space-time representation); neutron scattering and vibrational states of molecular crystals (vibrational states of a molecule, phonons in molecular crystals, the coherent scattering from phonons, incoherent phonon scattering). (UK)

19802 NEUTRON THERMALIZATION IN GRAPHITE. Mitsui, J.; Sugiyama, K. (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 1, 1-9(Jan 1973).

The neutron thermalization and diffusion parameters in graphite were determined by pulsed technique for the neutron flux and the neutron density spectra, respectively. Measurements were performed on assemblies of geometrical bucklings between $2.26 \times 10^{-3}/cm^2$ and $15.58 \times 10^{-3}/cm^2$, in which, by suitable arrangement of the neutron source and detector, the higher modes of spatial harmonics were diminished. The results indicated that it was necessary to wait $1.5 \sim 2$ msec after the injection of 14 MeV neutrons, in order to let the neutron spectrum attain its asymptotic form, independent of assembly size. The thermalization and diffusion parameters for both neutron flux and neutron density spectra were in good agreement with theoretical values. (auth)

19803 COMMENTS ON EFFECTIVE DIFFUSION COEFFICIENTS IN HETEROGENEOUS MEDIA. Takeda, T.; Sekiya, T. (Osaka Univ., Suita, Japan). Atomkernenergie; 21: No. 1, 73 (1973). (In German).

It is found that the image pile assumption, used in a paper by M. M. R. Williams to derive anisotropic diffusion coefficients, can be removed. (RWR)

19804 NEUTRON TRANSPORT EQUATION IN A FORM CONVENIENT FOR OBTAINING APPROXIMATE THERMALIZATION EQUATIONS. Laletin, N. I. At. Energ. (USSR); 34: No. 6, 445-449(Jun 1973). (In Russian).

The neutron transport equation, describing neutron thermalization in an infinite homogeneous medium, can be transformed to a form convenient for obtaining approximate thermalization equation. The necessary conditions for obtaining these known approxi-

mate equations from the exact equation are formulated. (12 references) (auth)

19805 SEMI-ANALYTICAL METHOD FOR TREATING NEUTRON SLOWING-DOWN ON A MIXTURE OF ELEMENTS. Cuculeanu, V.; Ixaru, L. G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 18: No. 5, 547-555(1973).

It is proven that the first order differential equation is not sufficient to approximate the integral slowing-down equation. To improve the results, a better approximation is introduced which results in a second order differential equation. This equation is solved numerically by means of a new semi-analytical method which is more suitable than the standard ones. This method is used for solving the physical case of the neutron slowing-down on the media which consist of the mixture of elements. (auth)

19806 NEUTRON WAVE MILNE PROBLEM IN POLYCRYSTALLINE MEDIA. Yamagishi, T. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 10: No. 1, 22-28(Jan 1973).

The Milne problem of neutron wave propagation in polycrystalline media is solved by using the half-range orthogonality for the complete set of eigenfunctions derived in a previous paper. The emergent distribution at the free surface exhibits a singularity when the discrete space eigenvalue attains that of the continuum in the spectral plane. This resonance phenomenon is demonstrated by numerical calculations for beryllium and graphite. The deformation of the energy spectrum in the directions parallel and perpendicular to the free surface is also shown for various oscillation frequencies. (auth)

19807 EFFECT OF SHAPE OF THE ASSEMBLY ON THE DECAY CONSTANT IN PULSED-NEUTRON EXPERIMENTS. Ahmed, F. (Univ. of Florida, Gainesville); Mohan, R. Nucl. Sci. Eng.; 51: No. 3, 335-337(Jul 1973).

The multigroup diffusion equation was solved by taking buckling to be energy dependent. This form of the solution is justified in the paper. It has two distinct advantages: the decay constant values so obtained are closer to the experimental results than ones obtained by taking constant buckling, and it gives a decay constant dependent on the shape of the assembly. (auth)

19808 INTEGRAL PHONON EFFECTS IN THE THERMAL NEUTRON SCATTERING FROM VANADIUM LATTICE. Kamal, M. Providence; Univ. of Rhode Island (1973). 252p. University Microfilms Order No. 73-16,737.

Thesis (Ph. D.).

The purpose of these investigations is to measure integral phonon effects in the interaction of slow neutrons with vanadium lattice. These effects depend upon the frequency spectrum of the lattice. The first moment of the inverse of the frequency is directly proportional to the temperature dependent mean squared displacement of the atoms. A multifold convolution of the frequency spectrum determines the total scattering cross section. From the measurement of inelastic scattering the frequency spectrum was determined. The inelastically scattered neutrons from a vanadium disc at angle of 80.5° and initial wavelength $\lambda = 2.207$ Å were corrected for changes in reflectivity of the analyzing crystal, order contaminations, resolution correction and the kinematical factors. The results can be fitted in terms of three gaussians. Experimentally the mean squared displacement is measured by measuring the differential elastic scattering cross sections at various scattering angles and sample temperatures. The results show that at room temperature anharmonic effects contribute and are approximately 10%. At low temperatures the mean squared displacement is lower than the calculated values using our results of the frequency spectrum. A possible explanation could be the preferential shrinkage of the low frequency modes of vibrations. The total scattering cross section of vanadium is measured for neutron energies of 0.0478 eV to 0.925 eV at the sample temperatures of 4.2°K, 10°K, 40°K, 100°K and 290°K. The results show that the measured values of the scattering cross section for the four lower temperatures are essentially the same within the experimental errors but differ appreciably from the room temperature values. The low temperature results show a change of 2 to 3 percent from 0.0478 eV to 0.925 eV. The room temperature results are approximately 5 percent higher compared to the low temperature values. The experimental results are compared with the theoretical calculations using three different methods, namely the Placzek's incoherent approximation, Sjolander's Gaussian approximation and direct evaluation of the cross section using the experimental frequency spectrum. The necessary background in terms of elements of lattice dynamics and the basic neutron interaction with condensed matter are given. (Diss. Abstr. Int., B)

19809 INNER ITERATION ERROR IN THE S_N ALGORITHM. Atkinson, G. L. (Office of the Secretary of Defense, Washington, DC); Kerr, W.; Duderstadt, J. J. Nucl. Sci. Eng.; 51: No. 3, 324-330(Jul 1973).

The discrete-ordinates algorithm in plane geometry is formulated within a mathematical framework which allows a detailed analysis of its convergence properties. The infinity norm of the iteration matrix is explicitly calculated for a slab geometry with a homogeneous isotropically scattering medium. This approach permits the calculation of a new convergence criterion which, along with the demonstrated convergence properties of the S_N algorithm, guarantees that the fractional iterative error is arbitrarily small. (auth)

19810 MEASUREMENTS AND CALCULATIONS OF THE NEUTRON SPECTRA FROM IRON BOMBARDED WITH 14-MeV NEUTRONS. Hansen, L. F.; Anderson, J. D.; Brown, P. S.; Howerton, R. J.; Kammerdiener, J. L.; Logan, C. M.; Plechaty, E. F.; Wong, C. (Univ. of California, Livermore). Nucl. Sci. Eng.; 51: No. 3, 278-295(Jul 1973).

The neutron spectra from 0.9, 2.9, and 4.8 mfp of iron for a 14-MeV neutron source were measured between 14 MeV and 10 keV by using the sphere transmission and time-of-flight techniques. The spectra also were calculated by using the Monte Carlo neutron transport code TART. To reproduce the measurements a revision of the Lawrence Livermore Laboratory neutron library was carried out. The cross sections were obtained from reported measurements, and a discussion of the revised neutron cross sections is presented. Very good agreement between measurements and calculations was obtained as a function of mean-free-path throughout the entire neutron energy spectrum. Calculations were also carried out with the ENDF/B-III neutron library and compared with the measurements. (13 figures) (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 19529 and 19830.

19811 (LA-UR-73-625) REPORTS TO THE U. S. NUCLEAR DATA COMMITTEE. Moore, M. S. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 22p. (CONF-730535-1). Dep. NTIS $3.25.

From U.S. Nuclear Data Committee meeting; Oak Ridge, Tennessee, USA (9 May 1973).

Work in progress at Los Alamos Scientific Laboratory that is germane to the interests of the U. S. Nuclear Data Committee is briefly reported. The material is presented under the following headings: neutron cross sections, nuclear spectroscopy: studies of radioactive nuclei, materials identification and analysis with stopped muons, evaluation, biomedical applications, controlled thermonuclear research, and other applied problems: neutron response of thermoluminescent dosimeters. (2 figures, 3 tables) (RWR)

For title listings of selected papers see: 19812, 19813, and 19976.

19812 (LA-UR-73-625, pp 4-6) n-^{3}He AND n-T CROSS SECTIONS. Seagrave; Berman; Drosg. 1972.

From U.S. Nuclear Data Committee meeting; Oak Ridge, TN (9 May 1973).

In Reports to the U.S. Nuclear Data Committee.

19813 (LA-UR-73-625, pp 17) d-^{3}He SPIN CORRELATION EXPERIMENT. Ohlsen (Rice Univ., Houston, TX); Hardekopf; Baker; May. [nd].

From U.S. Nuclear Data Committee meeting; Oak Ridge, TN (9 May 1973).

In Reports to the U.S. Nuclear Data Committee.

19814 BREMSSTRAHLUNG IN PROTON-ALPHA SCATTERING. Anzelon, G. A. Los Angeles; Univ. of California (1973). 110p. University Microfilms Order No. 73-16,676.

Thesis (Ph. D.).

The cross section for bremsstrahlung in the scattering of protons by alpha particles was measured at the sector-focused cyclotron facility of the University of California, Los Angeles. The scattered proton and recoil alpha particle were detected in coincidence, in a coplanar geometry, using silicon detector telescopes. Measurements were performed both above and below the threshold for proton-induced breakup of the ^{4}He nucleus, at the following experimental conditions: $E_p = 45.0$ MeV, $\theta_p = 91°$, $\theta_\alpha = 30°$, $E_p = 45.0$ MeV, $\theta_p = 70°$, $\theta_\alpha = 39°$, $E_p = 39.7$ MeV, $\theta_p = 92°$, $\theta_\alpha = 30°$. A primary motivation for the measurement was to examine whether, in the energy region up to 50 MeV, the alpha particle behaved as a single particle or as

an assemblage of two neutrons and two protons. It was also desired to examine the adequacy of a potential-independent theoretical model which did not explicitly treat off-energy-shell degrees of freedom in the proton-alpha interaction. Finally, it was hoped that something could be learned about the effect of final-state resonances upon the cross section, a topic which was of concern in the low-energy experiments of Wölfli, Hall, and Müller and in the theoretical work of Green and Prodon, who used the model-independent Feshbach-Yennie formalism and treated the ^{4}He nucleus as a single particle. The approach of Green and Prodon has been refined and modified to extend its validity to the energy range of these experiments. The theoretical basis of the calculations is discussed in some detail, with particular attention to the relation between the rescattering process and final-state resonances. The noncoplanar behavior of the cross section is discussed as well. (Diss. Abstr. Int., B)

19815 VARIATIONAL APPROACH TO ^{4}He WITH SEPARATION OF CENTER-OF-MASS MOTION. Pacati, F. D.; Boffi, S. (Univ., Pavia, Italy). Lett. Nuovo Cim.; 7: No. 14, 621-624(4 Aug 1973).

A correct result for the problem of separating the center-of-mass motion should be obtained in a variational calculation using trial wave functions, in which the center-of-mass motion is a priori excluded. This can be made by introducing a pseudometric in the Hilbert space. The case of helium-4 ground-state properties is considered. (JFP)

19816 TENSOR POLARIZATION IN NUCLEON-DEUTERON SCATTERING WITH TWO-TERM NONLOCAL SEPARABLE POTENTIALS. Fayard, C.; Lamot, G. H.; Elbaz, E. (Univ. Claude Bernard de Lyon, Villeurbanne, France). Lett. Nuovo Cim.; 7: No. 11, 423-429(14 Jul 1973).

Tensor polarizations in nucleon-deuteron scattering are obtained in a coupled calculation using different separable interactions of rank two for $^1S_0$ and $^3S_1$ - $^3D_1$ partial waves. It is concluded that the replacement of the Yamaguchi tensor force by a higher-rank separable interaction does not give a sensitive change on the tensor polarizations. (LBS)

19817 BREAK-UP PROCESSES IN NEUTRON-DEUTERON SCATTERING. Kloet, W. M.; Tjon, J. A. (Univ., Utrecht). Nucl. Phys., A; A210: No. 2, 380-396(1973).

Neutron-deuteron break-up reactions for kinematically complete and incomplete situations are examined for various types of local two-nucleon S-wave potentials and for the separable Yamaguchi potential. In particular, a systematic search has been made in the entire phase space of three free nucleons for large differences between the results of the various interactions. Certain parts outside the final state peaks and the quasifree scattering regions are found which are significantly sensitive to the two-nucleon interactions studied. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 18249, 18274, 19858, 19876, 19893, 19922, and 19967.

19818 (AD-758237) OXYGEN-16 PLUS NEUTRON SYSTEM IN A UNIFIED THEORY FORMALISM. Final Report, September 1971-August 1972. Leung, T. T. (Technology, Inc., Dayton, Ohio). Feb 1973. Contract F33615-71-C-1463. 100p. (ARL-73-11). NTIS.

A collective-model unified theory is developed, and it is shown to be equivalent to Feshbach's unified theory when a unit-step operator is used for the channel projector. Application is made to the ^{16}O + n system. Calculations of the ^{17}O level structure and cross section and of the angular distributions and polarization of neutron scattering by ^{16}O are presented. (auth)

19819 (CONF-700705-(Vol. 1), pp 403-413) COMBINATION OF IONOGRAPHIC EMULSIONS AND SOLID VISUAL DETECTORS IN A HIGH-ENERGY EXPERIMENT AT CERN: PRODUCTION OF NUCLIDES BY MEANS OF THE INTERACTION OF 19 GeV PROTONS WITH VARIOUS TARGETS. Alard, J. P. (Laboratoire de Physique Nucleaire Fondamentale et Developpement, Clermont-Ferrand, France); Bolta, J. M.; Cordaillat, A.; Melia, J.; Pfohl, R.; Sicre, A. 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The study of the production of fragments in high-energy interactions is of interest both in astrophysics (study of cosmic radiation) and in the field of nuclear structure (study of mechanisms of production). The study of particles with a charge of 1 and 2 made with an emulsion has given the abundance ratio for ^{4}He/^{3}He as 0.56 ± 0.09 in the range 500 to 900 MeV/c. Various mechanisms are required to explain the relative abundance of emitted nuclides. The study of particles with charge greater than 2 was made with collodion as the detector permitting a total incident flux of 10^{15} protons. Among the collection of hammer tracks of $^8_3$Li and $^8_5$B, evidence was found for the very rare nucleus $^8_2$He and probably $^8_6$C. (5 figures) (tr-auth)

19820 (CONF-700705-(Vol. 1), pp 415-422) STUDY OF DOUBLE CHARGE EXCHANGE OF MESONS ON LIGHT NUCLEI BY MEANS OF THE TECHNIQUE OF IONOGRAPHIC EMULSIONS AND HEAVY LIQUID BUBBLE CHAMBERS. Massue, J. P.; Batusov, I.; Cuer, P.; Sidorov, V. M. (CNRS, Strasbourg). 1970. (In French).

From 7th international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The general equation for the double charge exchange of pions is $\pi^\pm + A(Z,N) \rightarrow \pi^\mp + A(Z \pm 2, N \mp 2)$. With this process one can study excited nuclei with $\Delta T_3 = \pm 2$; one can do charge-symmetric reactions and test the structure of light nuclei and correlations existent in them. In addition, one can obtain new neutron-rich or -deficient nuclei. Double charge exchange of π^+ on ^{12}C was studied first. Measurement of the stars in the ionographic emulsions enabled determination of the different reactions possible; reactions with four, five, six, and seven visible branches were observed. The total cross section was measured in a propane bubble chamber; values found were 1.24 mb at 140 MeV and 1.85 mb at 190 MeV. Proton energy spectra measured by the two techniques are shown. Preliminary analysis of double charge exchange with K- beams at 1.5 GeV/c yielded a cross section of at least 14 mb. The combination of these two techniques enables one to study both the mechanism of double charge exchange and to determine the total cross section. (2 figures, 2 photographs). (RWR)

19821 (CONF-700705-(Vol.2), pp 429-433) FORMATION OF THE 17.64- AND 18.15-MeV LEVELS OF ^{8}Be BY THE REACTION ^{9}Be(^{3}He,α)^{8}Be STUDIED AT 5 MeV. Ferrero, J. L. (Univ., Valencia); Garcia, A.; Bilwes-Bourotte, B.; Bilwes, R. 1970. (In French).

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

On excitation above 16 MeV, ^{8}Be presents a succession of characteristic doublets. A detailed study of the 2^+ doublet makes evident the strong mixture of isobaric spin of the levels, and makes it possible to propose a theoretical description of the group of doublets. A large number of experimental results, however, appears to be necessary to support this model in the case of the 1^+ and 3^+ doublets. In the first stage, the study was approached from the 1^+ doublet with the aid of the ^{9}Be(^{3}He,α) reaction. This reaction possesses a high Q value (18.913 MeV). Consequently, it is interesting for studying a region of excitation that is also high (the 1^+ doublet includes a level at 17.64 MeV and one at 18.15 MeV). (3 figures) (tr-auth)

19822 (CONF-700705-(Vol.2), pp 435-440) STUDY OF THREE-PARTICLE ^{7}Li(n,αtn) REACTIONS BY NUCLEAR EMULSIONS. Antolkovic, B.; Turk, M.; Winterhalter, D. (Inst. Ruder Boskovic, Zagreb). 1970.

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

A method of using nuclear emulsions in complete measurements of neutron-induced reactions with three or more particles in the final state is described. The nuclear emulsions are loaded with the element on which the reactions are to be studied; such an arrangement offers almost 4π geometry. This results in higher yield; in addition, it does not overestimate contributions of processes that tend to be coplanar with the beam direction. Disadvantages to the method include high background and the rather low particle energies required. This method was used to study the n + ^{7}Li reaction at 14.4 MeV. Tracks in the emulsions were analyzed by computer. The three-body final state (α,t,n) can be reached by simultaneous breakup or a number of sequential decays. Study of the energy spectra indicated that the primary reaction mechanism was one of formation of n + ^{7}Li, which subsequently decayed into α + t. The t + ^{5}He $\rightarrow$ α + n final state was also important. Simultaneous breakup added a negligible contribution. (3 figures) (RWR)

19823 (COO-1717-6) DIFFERENTIAL CROSS SECTION AND POLARIZATION FOR 2.63-MeV NEUTRONS SCATTERED FROM ^{12}C. Knox, H. D.; Cox, J. M.; Finlay, R. W.; Lane, R. O. (Ohio Univ., Athens (USA). John E. Edwards Accelerator Lab.). 2 Jul 1973. Contract AT(11-1)-1717. 43p. Dep. NTIS $4.25.

The differential cross section and differential polarization of 2.63 MeV neutrons scattered from ^{12}C have been measured at eight angles between 17 and 118° in the laboratory system. By simultaneously fitting the cross section and polarization data, a set of scattering phase shifts was obtained. The values of the re-

sulting d-wave phase shifts were larger than those of other existing sets of phase shifts in the energy region. A subsequent R function analysis, reflecting these larger d-wave phase shifts, gave excellent fits to other experimental data below 3 MeV neutron energy region. The influence of narrow states at 7.50 and 7.55 MeV excitation energy in ^{13}C is discussed. (auth)

19824 (COO-3274-8) NUCLEAR MOMENTS AND NUCLEAR STRUCTURE. Annual Progress Report, January 1, 1973-May 31, 1973. Madansky, L.; Lee, Y. K. (Johns Hopkins Univ., Baltimore, MD). 1973. Contract AT(11-1)-3274. 29p. Dep. NTIS $3.50.

In the nuclear moments program, the nuclear quadrupole couplings of ^{12}N in single crystals of Be and Mg were measured. Moreover, the relative intensities of the resonance lines arising from two stopping sites for ^{12}B in Be seemed to depend upon the orientation of the crystalline c-axis with respect to the recoil direction. An experiment was designed to investigate this orientational dependence. A polarimeter was used to measure the linear polarization of gamma rays from very high spin states in nuclei produced in (HI,xn) reactions. The Moessbauer effect was used to study temperature spikes in solids following Coulomb excitation and the magnetic properties of antiferromagnetic Ni-Fe alloys. Work on the development of a high-count rate gas-flow proportional counter is discussed. New projects on the diffusion of charged particles and radiative effects following heavy-ion collisions are briefly described. (3 figures, 3 tables) (RWR)

For title listing of selected paper see: 19900.

19825 (EANDC(E)-157-U(Vol.1), pp 42-43) EXCITATION FUNCTION OF THE REACTION $^{12}C(n,2n)^{11}C$ FROM THE THRESHOLD UP TO 34-MeV NEUTRON ENERGY. Anders, B.; Bormann, M.; Scobel, W. (Univ., Hamburg). Mar 1973.

19826 (EURFNR-1097) TOTAL NEUTRON CROSS SECTION OF BORON 10 BETWEEN 90 AND 420 KeV. Spencer, R. R.; Beer, H.; Froehner, F. H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Jan 1973. 9p. (KFK-1518; EANDC(E)-147(AL)). Dep. NTIS (U. S. Sales Only) $3.00.

Work performed under United States-Euratom Fast Reactor Exchange Program.

The neutron total cross section of ^{10}B was determined between 90 and 420 keV neutron energy by means of a transmission measurement of an enriched ^{10}B sample. Deviations in shape to other measurements are within the statistical accuracy of the present measurement and smaller than 1.5%. In the measured energy region no indication of narrow resonance structure was found, and the deviation of the total cross section from an $E^{-\frac{1}{2}}$ energy dependence above 100 keV was confirmed. (auth)

19827 (FRNC-TH-374) STUDY OF π^--^{12}C ELASTIC SCATTERING AT MEDIUM ENERGIES USING THE OPTICAL MODEL. Maillet, J. P. (Paris Univ., Orsay (France)). 1972. 83p. (In French). Dep. NTIS (U. S. Sales Only) $6.25.

Thesis.

Medium energy elastic scattering π^--^{12}C experiments are analyzed in the framework of Watson multiple scattering with a Kisslinger potential. It is shown that this potential leads to a satisfactory interpretation of the experimental results. The principal approximations are analyzed. The agreement with experiment was improved by first order corrections. It was also verified that certain approximations compensate one another: the absence of corrections for the motion of the center of mass is practically corrected for by the many nucleon approximation. The impulse approximation implies an energy shift of the order of 20 MeV which reduces to 6 MeV if the Fermi motion is taken into consideration. In spite of the fact that the evaluation of the second order potential is not very precise, the results obtained demonstrate that beyond 120 MeV the validity of the coherent scattering approximation becomes doubtful. (auth)

19828 (FRNC-TH-378) OPTICAL ANALYSIS OF THE ELASTIC SCATTERING OF ^6Li ON ^{11}B, ^{12}C, AND ^{13}C AT 28 MeV. Traore, B. M. (Paris Univ., Orsay (France)). 1972. 63p. (In French). Dep. NTIS (U. S. Sales Only) $5.25.

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

A detailed investigation of the parameters obtained from the analysis of the distributions observed in the elastic scattering of ^6Li on ^{11}B, ^{12}C, and ^{13}C at 28 MeV was carried out using the optical model. An automatic retrieval program was used for the optical potential parameters (MAGALI program), the mean standard deviations between the experimental and calculated cross sections being minimized. For a fixed value of the reduced radius r_v several sets of parameters exist for which the X^2 curve presents a minimum. The formation of the compound nucleus and the exchange reaction mechanisms are proposed as possible mechanisms. The importance of these contributions is evaluated for the case of a ^{12}C target using two models. A model based on the Hauser-Feshbach formalism for the first mechanism, a model based on the use of the finite range DWBA for the exchange reaction. In both cases the contributions are negligible. Several types of ambiguity appear: discontinuous ambiguity in the depth of the real well and a continuous ambiguity; ambiguity between the surface and volume absorptions and a continuous ambiguity for imaginary wells. For all the families of parameters producing a satisfactory smoothing, the tails of the real wells and those of the imaginary wells become almost identical when r is of the order of 5 to 6 fm. (FR)

19829 (LBL-2052) HIGH-ENERGY HEAVY IONS: A NEW AREA FOR PHYSICS RESEARCH. Heckman, H. H. (California Univ., Berkeley. Lawrence Berkeley Lab.). 15 Jun 1973. Contract W-7405-eng-48. 37p. (CONF-730642-7). Dep. NTIS $4.00.

From 5th international conference on high-energy physics and nuclear structure; Uppsala, Sweden (18 Jun 1973).

Emerging from the first heavy-ion experiments at the Bevatron are preliminary results that reveal high-energy heavy-ion research to be a promising and stimulating new area of physics research, pertinent to elementary particles, nuclear structure, and cosmic rays. Among the heavy-ion physics experiments in progress at the Bevatron are studies on the fragmentation of projectile and target nuclei, coherent pion production, and the production and detection of high-energy hypernuclei. The experiments on the fragmentation of beam nuclei at 1.05 and 2.1 GeV/nucleon have shown specific relevance to contemporary theory on inclusive reactions, particularly to the concept of factorization, i.e., the modes of fragmentation of beam nuclei are independent of the target nucleus. Complementary experiments on the fragmentation of target nuclei are concerned with the characteristic differences between the production of light and heavy fragments from heavy-element targets under bombardment by p, ^{12}C, and ^{16}O beams at 2.1 GeV/nucleon. The investigation on the feasibility of producing high-energy hyperfragments, via the two-body reaction $^{A}Z + p \rightarrow {}^{A}{}_{\Lambda}{}^{1}Z + K^+$, where the target proton and heavy ion projectile become, respectively, a K^+ and a high velocity hyperfragment, may lead to a new technique in the field of hypernuclear physics. (auth)

19830 (ORO-2408-51) STUDIES OF NUCLEAR PROCESSES. Progress Report, June 1, 1972-May 31, 1973. Clegg, T. B.; Ludwig, E. J.; Merzbacher, E.; Shafroth, S. M.; Thompson, W. J. (North Carolina Univ., Chapel Hill). 1973. Contract AT(40-1)-2408. 29p. Dep. NTIS $3.50.

The studies of nuclear processes conducted by the Chapel Hill group affiliated with the Triangle Universities Nuclear Laboratory (TUNL) have continued to emphasize the following topics: polarized proton beam experiments, polarized deuteron beam experiments, nuclear reactions and scattering, channeling experiments, atomic effects in nuclear bombardment, ion source development and other instrumentation, nuclear structure and reaction theory, and computer programming for nuclear theory and reaction data analysis. The Cyclo-graaff at TUNL and the 4-MeV Van de Graaff accelerator were the primary sources of particle beams. Computations were carried out on the computers at TUNL and at the Triangle Universities Computation Center. The research program has led to an enhanced understanding of the spin dependence of nuclear interactions revealed in experiments with polarized beams. Violent collisions between charged particles and complex atoms, leading to inner shell ionization, were studied in detail over a broad energy range. Considerable improvement in operation of the polarized ion source was put to immediate use in a wide variety of experiments, while possible further improvements were under investigation. (auth)

19831 ELASTIC SCATTERING OF IDENTICAL BOSONS. Reilly, W. J. New Haven; Yale Univ. (1972). 280p. University Microfilms Order No. 73-16,382.

Thesis (Ph. D.).

Measurements of the O^{16} + O^{16} elastic scattering excitation functions in the higher energy range of the MP tandem Van de Graaff accelerator have revealed new, interesting structure. Pronounced gross structure of characteristic width 2 MeV and with peak to valley ratios of the cross sections greater than 20:1 were found. This gross structure was reasonably well reproduced with a shallow optical model potential. Superimposed on this gross structure is a narrower, yet strong, intermediate structure with widths of several hundred keV whose origin is not well understood. Earlier excitation functions for the C^{12} + C^{12} system revealed interesting quasi-molecular resonances of width 100 keV just below the Coulomb barrier as well as statistical fluctuations at energies slightly above the barrier. The present studies extended the C^{12} + C^{12} data, and that for

the $N^{14} + N^{14}$ system, over the higher MP accelerator range to examine the extent to which the structure found in the $O^{16} + O^{16}$ system was present in those two systems. Five excitation functions were measured at θ_{CM} = 50, 60, 70, 80, and 90° for the $C^{12} + C^{12}$ system in the energy range 13 MeV ≤ E_{CM} ≤ 30 MeV. The $C^{12} + C^{12}$ excitation functions revealed strong intermediate structure with characteristic widths increasing systematically from 0.6 to 1.2 MeV over the measured energy range. Gross structure similar to that of the $O^{16} + O^{16}$ system is readily apparent when the excitation functions are energy averaged. The $N^{14} + N^{14}$ data revealed markedly smooth and relatively damped gross structure, but showed no evidence of intermediate structure. These new data were subjected to intensive optical model analyses and were fit with shallow optical model potentials similar to those earlier found suitable for the $O^{16} + O^{16}$ system. The parameters for $O^{16} + O^{16}$ had been V = 17 MeV, W = .4 + .1E_{CM}, a = .35F and r = 1.35F. For $C^{12} + C^{12}$ the parameters were: V = 17 MeV, W = .4 + 1E_{CM}, a = .35F, r_R = 1.35F and r_I = 1.40 F. For $N^{14} + N^{14}$ the parameters were: V = 15 MeV, W = .4 + .125E_{CM}, a = .49F and r = · 1.35F. Discrete ambiguities in V and continuous ambiguities in W were discovered. A systematic comparison of these three systems and others studied over a similar energy range yielded markedly similar optical model parameters. The existing parameter sets represent an important basis for extension to more elaborate heavy ion studies on transfer reactions, inelastic excitations, and the more complex reaction modes. The systematic extraction of interaction potentials and a better understanding of the intermediate structure in terms of the details of the individual nuclei involved can lead to new insight into the fundamental nucleus-nucleus interaction. (Diss. Abstr. Int., B)

19832 ROLES OF WEAK HADRON FORM FACTORS IN THE ALLOWED MUON CAPTURE PROCESSES IN LIGHT NUCLEI. Mukhopadhyay, N. C. (Univ. of Maryland, College Park). Lett. Nuovo Cim.; 7: No. 11, 460-464(14 Jul 1973).

The allowed muon capture transitions in the 1p-shell nuclei are examined to determine the relative contributions of various weak hadron terms in these processes, using the Fujii-Primakoff approximation and emphasizing the dominance of the Gamow-Teller operator in these transitions. It is shown that the rates for the dominant allowed transitions in the 1p-shell nuclei can be broken into percentage contributions from various form factors in a way that is qualitatively independent of the properties of the nuclear states. Results are given for various nuclei. (LBS)

19833 TRANSFER OF A NEUTRON BETWEEN ^{9}Be, ^{13}C, AND ^{17}O. Matter, U. Diss. Nr. 4461. Zurich; Eidgenoessische Technische Hochschule (1970). 42p. (In German).

Thesis.

The experiments were performed with a tandem Van de Graaff accelerator which furnished a ^{16}O beam of about 1μA and a ^{12}C beam of about 500 nA. Angular distribution of energy was measured near the Coulomb barrier. The theoretical analysis was based on the distorted-wave Born-approximation method. Angular distributions are given for the reactions ^{9}Be(^{16}O, ^{17}O) ^{8}Be, ^{13}C(^{16}O, ^{17}O) ^{12}C, and ^{9}Be(^{12}C, ^{13}C) ^{8}Be in the region 10 to 20 MeV; excitation functions are also shown for the first reaction. (HBG)

19834 CROSS SECTION OF THE ^{16}O(α,n)^{19}Ne REACTION BETWEEN 16.5 AND 22.5 MeV. Delacroix, E.; Labie, E.; Lega, J.; Macq, P. C. (Univ., Louvain, Belgium). J. Phys. (Paris); 34: No. 2, 175-177(Feb 1973). (In French).

The yield of the reaction ^{16}O(α,n)^{19}Ne was measured between the threshold and 22.5 MeV. This range of energy is characterized by a backward enhancement of the elastic differential cross section of α particles on ^{16}O. (FR)

19835 MOLECULAR-ORBITAL MODEL OF THE ATOMIC NUCLEI. Abe, Y.; Hiura, J.; Tanaka, H. (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 49: No. 3, 800-824(Mar 1973).

A new nuclear model is proposed that describes the cluster and the shell structures unifiedly. By the present model one can investigate characteristics of one-particle orbitals in clustering states and also polarizations of constituent clusters. The model has its base on the Hartree–Fock (H.F.) approximation for nuclear intrinsic states. The basis wave functions used in the present H.F. calculations are constructed from single-particle wave functions around each "cluster center", which can well describe possible large eccentric nuclear deformations in light nuclei. The model is analogous to the LCAO-MO-SCF method in the molecular physics. Numerical calculations are performed using an effective two-nucleon force (Volkov No. 1) for the ground states of ^{8}Be and ^{12}C nuclei, and interesting results are obtained about the stability of α-cluster structures. Polarizations are smallest at the equilibrium distance between α-clusters, determined by Brink's α-particle model. An artificial collapse or an extreme decomposition of the α-cluster structures brings about large polarizations. By those polarizations of constituent α-clusters themselves, the α-cluster structure recovers their density distributions. Comparisons of the results are made with those of two-center shell model, usual H.F. calculation and α-particle model. (auth)

19836 INVESTIGATION OF SOME ONE-NEUTRON-TRANSFER REACTIONS WITH ^{18}O AND ^{19}F BEAMS. Knoth, H. Diss. Nr. 4463. Zurich; Eidgenoessische Technische Hochschule (1970). 43p. (In German).

Thesis.

Measurements on the following single-neutron-transfer reactions are reported: ^{13}C(^{18}O,^{19}O)^{12}C, ^{9}Be(^{18}O,^{19}O)^{8}Be, ^{9}Be(^{18}O,^{17}O)^{10}Be, ^{10}B(^{18}O,^{17}O)^{11}B, and ^{10}B(^{19}F,^{18}F)^{11}B. Angular distributions were measured for two energies, one in the neighborhood of the Coulomb barrier and the other a few MeV lower. In addition, an angular distribution was measured at an even lower energy for the ^{13}C(^{18}O,^{19}O)^{12}C reaction. In order to determine how strongly the nuclear scattering in this energy region departs from pure Coulomb scattering, elastic scattering angular distributions were measured for each incident nucleus at the corresponding energy. The measurements were analyzed by the DWBA theory; and spectroscopic factors, extracted. Several important experimental aspects are discussed, as well as the estimated errors in the data. (13 figures, 2 tables) (RWR)

19837 STUDY OF MICROSCOPIC WAVE FUNCTIONS OF NUCLEAR LEVELS THROUGH INELASTIC SCATTERING OF 166 MeV α PARTICLES. Bimbot, L.; Tatischeff, B.; Brissaud, I.; Le Bronec, Y.; Frascaria, N.; Willis, A. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A210; No. 2, 397-420 (1973).

The inelastic cross sections of 166 MeV α-particles have been measured for the first collective levels of 22 nuclei. The experimental angular distributions are presented and compared, when possible, with DWBA calculations using microscopic wave functions. The importance of the choice of the optical potential, of the exchange term and of the Coulomb interaction, and the validity of the microscopic wave functions are discussed. (auth)

19838 ^{9}Be(p,α) AND (p,d) CROSS SECTIONS AT LOW ENERGIES. Sierk, A. J.; Tombrello, T. A. (California Inst. of Tech., Pasadena). Nucl. Phys.; A210: No. 2, 341-354(1973).

Cross sections for the ^{9}Be(p,d) and (p,α) reactions have been measured for proton lab energies of 30 to 700 keV. Angular distributions were measured for energies of 100 to 600 keV. Absolute normalization of the cross sections was done by measuring cross sections for Rutherford scattered α-particles. The maximum cross sections observed at the 330 keV (lab) $J^{\pi} = 1^{-}$ resonance were 360 ± 20 mb for (p,α) and 470 ± 30 mb for (p,d). The value of $S_{c.m.}$ (E = 0) for the combined cross sections was estimated to be 35^{+15}_{-5} MeV · b. The reaction data were interpreted in terms of an R-matrix compound nucleus model. There were no obvious effects due to direct reactions. The low-energy behavior of the cross sections was fitted by using three ^{10}B resonance levels; a $J^{\pi} = 2^{+}$ level at −20 keV (c.m.), a 1^{-} level at 310 keV (c.m.) and a 1^{+} level at 410 keV (c.m.). (auth)

19839 ELASTIC SCATTERING OF TRITONS BY ^{16}O. Wery, M. (Laboratoire des Basses Energies, Strasbourg). Nucl. Phys.; A210: No. 2, 329-340(1973).

Angular distributions and excitation functions have been measured for the ^{16}O(t,t) reaction from 1.4 to 3.7 MeV triton energy using a differentially pumped gas target. The observed resonances have been analyzed with the Humblet–Rosenfeld theory. It appears that the 13–15 MeV excitation range of the compound system of ^{19}F is dominated by several levels of large triton partial width. Levels populated in the three-particle transfer reaction (^{7}Li,α) on ^{16}O are compared with the resonances. (auth)

19840 CALCULATIONS ON THE SCATTERING OF keV NEUTRONS FROM THE ^{7}Li(p,n)^{7}Be REACTION IN A TYPICAL TARGET ASSEMBLY. Ryves, T. B. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy; 27: No. 6, 365-376(Jun 1973).

The angular distributions and energy spectra of keV neutrons scattered from a typical target assembly employing the ^{7}Li(p,n)^{7}Be reaction have been calculated by the Monte Carlo method for several proton energies, target backing and beam tube wall thicknesses, and target radii. A brief discussion is given of possible errors due to scattering in the experimental measurements of neutron activation capture cross-sections, dose equivalents and angular distributions. (auth)

19841 STUDY OF THE CHARGED PARTICLE EMISSIONS OF ^{12}C FOLLOWING PROTON CAPTURE BY ^{11}B. Thompson, W. B.

New Haven; Yale Univ. (1972). 144p. University Microfilms Order No. 73-16,402.

Thesis (Ph. D.).

The giant resonance in ^{12}C occurs at 22.5 MeV. Above it at approximately 26 MeV is a strong second resonance thought to be built upon the 2+ first excited state of ^{12}C. Both of these have been observed in photoexcitation and radiative capture studies, but the present theoretical explanations of ^{12}C have failed to duplicate the detailed shape of either resonance. The charged particle decays of ^{12}C, $^{11}B(p,p_0)^{11}B$, $^{11}B(p,p_1)^{11}B(2.14)$, $^{11}B(p,\alpha_0)^{8}Be$ were investigated to determine whether structure observed in the (p,γ) and (γ,p) studies implies activity in the particle channels. The angle and energy dependence of the proton and alpha decays for incident proton energies between 7.5 and 21.5 MeV is presented. Particle-hole interpretations of the ^{12}C structure inadequately describe the elastic scattering; whereas, an optical model for low Z nuclei shows good agreement with the p_0 data. The inelastic processes are also best analyzed with a direct reaction theory such as the DWBA. Two alpha cluster models for ^{12}C are cited and a PWBA which includes the pickup of the target core is shown to reproduce the (p,α) angular distributions. (Diss. Abstr. Int., B)

19842 STUDY OF T = 3/2 STATES IN ^{17}F. Skwiersky, B. M. New Haven; Yale Univ. (1972). 78p. University Microfilms Order No. 73-16,397.

Thesis (Ph. D.).

Information pertaining to the first seven T = 3/2 states in ^{17}F was obtained by observing compound nuclear resonances in any or all of the ^{16}O + p exit channels, $(p,p_0)^{16}O$, $(p,p_1+p_2)^{16}O(E_x = 6.05$ MeV, 6.13 MeV), $(p,p_3+p_4)^{16}O(E_x = 6.92$ MeV, 7.12 MeV), and $(p,\alpha_0)^{13}N(Q = -5.22$ MeV). A survey of the energy region E_p = 13.23 MeV to 16.60 MeV in steps of from 1 keV to 5 keV at five or six laboratory angles, uncovered two previously unobserved stated at $E_p = 13.27 \pm .004$ MeV and $14.017 \pm .004$ MeV, suspected of being the fourth and fifth T = 3/2 analogs of ^{17}N. In order to corroborate the suspected T = 3/2 identity of the states seen, a phase-shift analysis was undertaken. Off-resonance phase-shifts, necessary for the analysis, were extracted from elastic scattering angular distributions (29 angles at $\theta_{lab} = 25°-165°$) taken in 50-keV steps from E_p = 9.0 MeV to 20.35 MeV. The optical model code JIB3 (utilized with the optical potential starting parameters of Watson) yielded a fairly smoothly varying set of background phase-shifts. These enabled the assignment of spins and parities for all but one of the states studied—the T = 3/2 analog of the $^{17}N(E_p = 1.91$ MeV) state. This state was too weak in the proton exit channel to evaluate its shape against the predictions of the phase-shift analysis. (Diss. Abstr. Int., B)

19843 RADIATIVE HELION CAPTURE IN ^{12}C AND ^{16}O. Shay, H. D. New Haven; Yale Univ. (1972). 291p. University Microfilms Order No. 73-16,394.

Thesis (Ph. D.).

A comprehensive study has been completed on the helion radiative capture reactions leading to the first four states of ^{12}C and the first five states of ^{16}O. Excitation functions have been extended to 45 excitations. Angular distributions have been taken at many key energies. These experiments utilized the Wright Nuclear Structure Laboratory MP tandem accelerator, a large NaI(Tl) gamma radiation detector and plastic scintillator cosmic ray anti-coincidence shield built as part of this program, and the IBM 360/44 on-line data acquisition system. Several resonances have been found. The role of 3p-3h configurations immediately above the giant resonances of these nuclei has been demonstrated to be significant. Microscopic R-matrix calculations based on the Wang and Shakin 1p-1h and 3p-3h ^{16}O wavefunctions have been conducted. Detailed comparison of these calculations with the data and $^{15}N(p,\gamma_0)^{16}O$ data suggests that the source of much of the intermediate structure seen in the ^{16}O giant resonance may stem from the mixing of 1p-1h doorway configurations with 3p-3h configurations. (Diss. Abstr. Int., B)

19844 COMPOUND NUCLEUS RESONANCES AND DIRECT INTERACTION IN THE REACTION D + ^{12}C. Berrada, M.; Marquez, L. (CEN, Bordeaux). Particles Nucl.; 5: No. 2-3, 89-102(1973).

The angular distributions of the reactions $^{12}C(d,p_0)$, $^{12}C(d,p_1)$ (3.09 MeV), $^{12}C(d,p_2)$ (3.69 MeV), and $^{12}C(d,p_3)$ (3.86 MeV) were studied around the two resonances of ^{14}N at E_d = 2.50 MeV and E_d = 2.72 MeV. Variations of shape, sometimes very striking, were observed on the resonances. The analysis allowed extraction of a term of interference relatively weak when compared to the direct and compound nucleus mechanisms. The spins and parities of the two resonances were confirmed as 4^- and 3^+, respectively. (7 figures, 1 table) (auth)

19845 HIGH ENERGY p–^{12}C SCATTERING AND NUCLEAR COLLECTIVE MOTION. Friar, J. L. (Massachusetts Inst. of Tech., Cambridge). Particles Nucl.; 5: No. 2-3, 45-65(1973).

The differential cross section for the elastic scattering of 1-GeV protons by ^{12}C was calculated by using the optical-model version of Glauber's method for constructing high-energy scattering amplitudes. The effect of long-range correlations was estimated by using a macroscopic collective model to describe the low-lying 2^+(4.44 MeV), 0^+(7.6 MeV), and 3^-(9.6 MeV) states. These states make a correction to the optical potential through the second-order correlation function, which usually includes only Pauli and center-of-mass correlations. These corrections enhance the agreement between theory and experiment. In addition, the differential cross section for scattering and excitation of the low-lying states was calculated by using the same model, and is in substantial agreement with experiment. The relation between this model and the deformed-optical-potential model is thoroughly discussed. (6 figures) (auth)

19846 PROPOSED STRUCTURE OF THE 10.136-MeV $3/2^-$ STATE IN ^{19}F. Fortune, H. T. (Univ. of Pennsylvania, Philadelphia). Particles Nucl.; 4: No. 5-6, 245-249(1972).

By comparison with ^{20}Ne, the energy of the 10.136-MeV state of ^{19}F and its large alpha-particle reduced width for decay to the $1/2^+$ state at 5.300 MeV in ^{15}N suggests that the dominant configuration of the 10.136-MeV state is the SU(3) classification $(\lambda\mu) = (90)$ built on the $^{15}N(5.300)$ state. (auth)

19847 DOUBLE GAMMA DECAY IN LIGHT NUCLEI. Bertsch, G. F. (Michigan State Univ., East Lansing). Particles Nucl.; 4: No. 5-6, 237-244(1972).

The $O^+ \rightarrow O^+$ double gamma decay is calculated for the nuclei ^{12}C, ^{16}O, ^{40}Ca, ^{72}Ge and ^{90}Zr, using a model of the states with spherical and deformed components. Due to the similarity in the structure of the components, double gamma decay is always greatly hindered. However, for ^{16}O, the calculated transition matrix is too large by at least a factor of 3; in ^{40}Ca there is agreement with a recently reported measurement. (auth)

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Refer also to abstracts 19617, 19819, 19837, 19872, 19880, 19893, 19955, and 20002.

19848 (ANU-P-567) ALPHA CAPTURE TO THE ^{40}Ca GIANT QUADRUPOLE RESONANCE. Branford, D. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1973. 8p. Dep. NTIS (U.S. Sales Only) $3.00.

It is shown that the $^{36}Ar(\alpha,\gamma_0)^{40}Ca$ reaction most probably excites a giant quadrupole resonance in addition to the giant dipole resonance. Properties of the giant quadrupole resonance and its effect on (p,γ) capture reactions are discussed. (2 figures) (auth)

19849 (ANU-P-573) POLARIZATION STUDIES OF GROUND-STATE RADIATION FROM THE 2.21 AND 2.73 MeV LEVELS OF ^{27}Al. Gardner, P. R.; Baxter, A. M.; Bell, R. A. I.; Carlson, L. E.; Kean, D. C.; Ophel, T. R.; Spear, R. H. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 17p. Dep. NTIS (U.S. Sales Only) $3.00.

The (E2/M1) mixing ratios of the ground-state gamma ray transitions from the 2.21 and 2.73 MeV levels of ^{27}Al have been measured using a three-crystal Compton polarimeter in order to resolve discrepancies between previous experimental results for the 2.73 MeV transition. (5 figures, 3 tables) (auth)

19850 (ANU-P-574) 1522 keV TRANSITION IN ^{28}Si. Carlson, L. E.; Branford, D.; Huang, F. C. P.; Ophel, T. R. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 9p. Dep. NTIS (U.S. Sales Only) $3.00.

Gamma–gamma directional correlation measurements on the γ-rays from the 1024 keV resonance in the $^{27}Al(p,\gamma)^{28}Si$ reaction are described. A result of $\tan^{-1}\delta = -68° \pm{}^{20}_{8}$ was obtained for the E2/M1 mixing ratio for the decay of the 7798 keV 3^+ level to the 6276 keV 3^+ level. This result is discussed with regard to the amplitude of T = 1 admixture into these states, the SU_3 model and a recent shell model and a recent shell model calculation. (1 figure, 1 table) (auth)

19851 (COO-3496-29, pp 37-44) DEPENDENCE OF NUCLEAR LEVEL WIDTH ON ISOSPIN FROM ERICSON FLUCTUATION MEASUREMENTS. Kildir, M.; Huizenga, J. R. 1973.

In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19852 (LUNP–7306) RECOIL PROPERTIES OF ^{27}Mg FROM THE $^{27}Al(\gamma,\pi^+)^{27}Mg$ REACTION. Friberg, B.; Blomqvist, I.; Forkman, B. (Lund Univ. (Sweden). Dept. of Physics). Apr 1973. 23p. Dep. NTIS (U. S. Sales Only) $3.25.

The mean ranges of the recoil nuclei from the reaction ^{27}Al

$(\gamma,\pi^+)^{27}$Mg have been measured at maximum bremsstrahlung energies of 250, 400 and 800 MeV using catcher-foil techniques. The experimentally determined ranges in directions along and perpendicular to the photon beam are in good agreement with calculated values based on the Fermi gas model and the impulse approximation. (5 figures, 2 tables) (auth)

19853 STUDY OF THE ^{28}Si AND ^{32}S LEVELS USING THE (^{3}He,d) REACTION AT 8 MeV. Kalifa, J.; Rotbard, G.; Vergnes, M.; Ronsin, G. (Paris Univ., Orsay, France). J. Phys. (Paris); 34: No. 2, 139-145(Feb 1973). (In French).

The study of the deuteron angular distributions demonstrated that the reactions ^{27}Al(^{3}He,d)^{28}Si and ^{31}P(^{3}He,d)^{32}S at 8 MeV proceed essentially by stripping. DWBA analysis is used to extract spectroscopic factors. Satisfactory agreement is found between experimental results and residual-interaction shell-model calculations. (FR)

19854 STUDY OF THE LEVELS OF THE ^{23}Na NUCLEUS. Kopanets, E. G.; Koval, A. A.; L'vov, A. N.; Kostin, V. Ya.; Migalenya, V. Ya.; Tsytko, S. P. (Physical Technical Inst., Kharkov). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 4, 863-869 (Apr 1972). (In Russian).

The radiative capture and inelastic collision of protons on a ^{22}Ne target nucleus were studied within the 1.2 to 3.0 MeV range of the protons accelerated by an electrostatic accelerator. The target was obtained by the implantation of ^{22}Ne on a tantalum support. The γ-ray yield was measured by means of NaI(Tl) crystal spectrometers; the γ radiation generated by the radiative capture of protons was detected using a Ge(Li) detector. Sixty-three resonances, identified as excited states of the ^{23}Na nucleus, were found in the excitation function of the ^{22}Ne(p,γ)^{23}Na reaction within the 1.2 to 3.0 MeV range. The excitation function of the ^{22}Ne(p,p')^{22}Ne reaction was studied within the 1.7 to 3.0 MeV range; the yield in the radiative capture and inelastic scattering reactions was measured simultaneously, making it possible to determine better the resonance energy of protons corresponding to the excited levels of ^{23}Na. The data indicated that the resonances in the ^{22}Ne(p,γ)^{23}Na reaction will be considered as isobaric analogs of the levels of ^{23}Ne. Further work is needed to confirm the results. (TTT)

19855 BRANCHING RATIOS, MEAN LIFETIMES, AND MULTIPOLE MIXING IN THE ^{24}Mg NUCLEUS. Leccia, F.; Aleonard, M. M.; Castera, D.; Hubert, P.; Mennrath, P. (Bordeaux Univ., Gradignan, France). J. Phys. (Paris); 34: No. 2, 147-158(Feb 1973). (In French).

Branching ratios and lifetime measurements of the first excited states of ^{24}Mg were determined by means of the ^{23}Na(p,γ)^{24}Mg reaction in the energy range 600 to 1500 keV. The Doppler shift attenuation method led to the values τ = 2000 ± 450, 40 ± 4, 88 ± 11, 120 ± 16, 83 ± 10, 110 ± 17, 2000 ± 550, 25 ± 5, 35 ± 11, 11 ± 7, 29 ± 7, 20 ± 7 and 25 ± 10 fs, respectively, for the levels E = 1.37, 4.12, 4.24, 5.24, 6.01, 6.43, 7.62, 7.75, 7.81, 8.43, 8.65, 8.86, and 9.52 MeV. E2/M1 mixing ratios of the transitions from the E = 4.24 (2^+), 5.24(3^+), and 7.81-MeV(5^+) levels were determined from angular distribution measurements. The experimental B(E2) values are compared with the predictions of collective and shell-model descriptions. (FR)

19856 MEASUREMENT OF THE BRANCHING RATIO FOR THE GAMMA TRANSITIONS FROM THE 4.235 MeV LEVEL OF ^{24}Mg. Branford, D. (Australian National Univ., Canberra). Aust. J. Phys.; 26: No. 2, 257-259(Apr 1973).

The branching ratio for the γ-transitions from the 4.235-MeV level of ^{24}Mg was measured following a study of the ^{23}Na(p,γ) resonances at 1021 and 1416 keV bombarding energy. The result, which is considerably more accurate than those reported previously, is compared with the predictions of the rotational model and shell model calculations. (auth)

19857 FAST-NEUTRON TOTAL CROSS SECTION OF Mg, Cl, K, Ca, 5.0/8.5 MeV. Fasoli, U.; Toniolo, D.; Zago, G. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 52: No. 4, 519-522(Apr 1972).

The neutron cross sections of the natural elements Mg, Cl, K, and Ca were measured in the energy interval from 5.0 to 8.5 MeV with an energy resolution of about 30 keV and statistical accuracy better than 2%. The measurement for Ca was also carried out from 1.5 to 5.0 MeV. The fluctuations observed had characteristics which could be interpreted in statistical terms. (1 figure) (tr-auth)

19858 PRECISION LIFETIMES OF POSITRON EMITTERS, ^{25}Al, ^{29}P, ^{33}Cl AND ^{41}Sc, AND ft VALUES OF MIRROR BETA DECAYS. Tanihata, I.; Minamisono, T.; Mizobuchi, A. (Osaka Univ., Toyonaka, Japan). J. Phys. Soc. Jap.; 34: No. 4, 848-852 (Apr 1973).

Half lives of positron decay of ^{25}Al, ^{29}P, ^{33}Cl, and ^{41}Sc have been determined to be (7.177 ± 0.023)s, (4.149 ± 0.005)s, (2.513 ± 0.004)s, and (0.591 ± 0.005)s, respectively. Each object activity was produced at a resonance energy of the proton-capture reaction to minimize the contamination due to other activities. The ft values of mirror β decay for 11 ≤ A ≤ 41, which were calculated by using a refined wave function of electron and the recent data, are presented. (auth)

19859 STUDIES OF LEVELS IN ^{29}P UP TO 4.76 MeV USING THE ^{28}Si(p,γ)^{29}P. Barnes, D. G.; Calvert, J. M.; Joy, T. (Univ. of Manchester, Eng.). J. Phys., A (London); 6: No. 7, 1011-1029 (Jul 1973).

Properties of seven of the first eight excited states in ^{29}P have been obtained from studies of the proton capture gamma radiation resonances at 720, 1381, 1652 and 2086 keV. Spin-parity assignments, branching ratios and multipole mixing ratios are deduced from angular distributions and lifetimes found from Doppler shift attenuation measurements. New measurements reported here are: 2423 keV level, lifetime of 70 ± 40 fs; 3450 keV level, $\Gamma_\gamma \leq 60$ μeV; 4344 level, δ (2.96) = 0.04; 4761 keV level, decays 90% to GS, 7% to 1.38 MeV level, 3% to 2.424 MeV level. There is evidence to suggest that the 4761 keV level is a doublet. (auth)

19860 ANALYSIS OF 104 MeV α-SCATTERING FROM ^{24}Mg USING A FOLDED COLLECTIVE MODEL. Mackintosh, R. S. (Australian National Univ., Canberra). Nucl. Phys.; A210: No. 2, 245-252(1973).

Using a folding method in which the spherical and non-spherical components of the optical potential are calculated consistently, it is shown that it is possible to get a simultaneous fit to the elastic and inelastic scattering of 104 MeV α-particles from ^{24}Mg. The deformation of the underlying nuclear matter distribution is much greater than that of the phenomenological optical potential. (auth)

19861 EXCHANGE EFFECTS ON THE EXCITATION OF ^{20}Ne BY PROTONS. Satchler, G. R. (Oak Ridge National Lab., TN). Particles Nucl.; 5: No. 2-3, 77-88(1973).

The importance of knock-on exchange is studied for the microscopic description of the excitation of collective states by inelastic scattering. Much of the discrepancy found earlier between theory and experiment may be removed by the inclusion of exchange. The usefulness of an equivalent zero-range pseudopotential is studied. Results are also presented for the dependence on the shell-model orbits involved and for the effects of imaginary, Coulomb, spin-dependent and odd-state components in the interaction. (3 figures, 2 tables) (auth)

19862 STUDY OF THE ^{20}Ne(^{3}He,n) REACTION FROM 2.5 TO 4.0 MeV. Bose, S. K. Cleveland; Case Western Reserve Univ. (1973). 85p. University Microfilms Order No. 73-16,114.

Thesis (Ph. D.).

The ground state of ^{22}Mg was studied through the ^{20}Ne(^{3}He,n) reaction with a ^{3}He beam obtained from the Case Western Reserve University 4-MV pulsed-terminal Van de Graaff accelerator. Data for the reaction cross sections were obtained with a neutron time-of-flight spectrometer. The yield of the neutrons from the above reaction leading to the ground state of ^{22}Mg was observed in the He^+ energy range of 2.5 to 4.01 MeV. Angular distributions were determined at 3.27, 3.69, and 4.01 MeV between 0° and 120° (lab). Excitation curves for the energy region were measured at 0° and 80° (lab). Calculations were performed to determine to what extent the DWBA theory could describe the experimental results, i.e., to what extent ^{20}Ne(^{3}He,n) can be described as a stripping reaction. Compound-nucleus contributions were taken into account to obtain a better agreement between theory and experiment. A spectroscopic factor was extracted from the absolute cross section measurements and found to be 0.50 ± .21. (Diss. Abstr. Int., B)

19863 ^{24}Mg LEVEL AT 11.86 MeV WITH $J^\pi = 8^+$ OR, LESS PROBABLY, 6^+. Branford, D.; Spooner, M. J.; Wright, I. F. (Univ. of Manchester, Eng.). Particles Nucl.; 4: No. 5-6, 231-236(1972).

Measurements on an 11.86 MeV level, which is populated strongly in the ^{12}C(^{16}O,α)^{24}Mg reaction, show that this level has $J^\pi = 8^+$ or less probably 6^+, a mean lifetime of 91 ± 35 fs and decays predominantly by γ-ray emission to the 6^+, level at 8.11 MeV. It could therefore be an 8^+ member of the ground state rotational band at 13.21 MeV. (auth)

19864 INELASTIC EFFECTS IN DIRECT REACTIONS: ^{20}Ne(d,^{3}He)^{19}F. Ellis, P. (Oxford Univ.); Dudek, A. Particles Nucl.; 5: No. 1, 1-22(Jan 1973).

The role of inelastic processes in the ^{20}Ne(d,^{3}He)^{19}F reaction at E_d = 52 MeV was examined. Three levels were coupled in both the entrance and exit channels and it was found that the inelastic processes, together with a small direct component, were able to

account quite well for the cross section of the $^{9}/_{2}^{+}$ level at 2.78 MeV. For the $^{1}/_{2}^{+}$ ground state and the $^{5}/_{2}^{+}$ level at 0.20 MeV, the inelastic processes were found to significantly modify the DWBA cross section mainly with regard to the magnitude, thereby improving agreement with experiment. The theoretical cross sections could be quite well reproduced by including in addition to the direct transition only those inelastic transitions that could proceed by an sd transfer and a one-step inelastic scattering via the β_2 deformation. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 17851, 19830, 19837, 19847, 19848, 19851, 19857, 19858, 19893, 20002, and 20012.

19865 (COO-3496-29, pp 44-49) CALCULATION OF THE LEVEL DENSITY AND SPIN CUT-OFF FACTOR WITH THE INCLUSION OF NUCLEAR PAIRING. Behkami, A. N.; Chan. G.; Huizenga, J. R. 1973.

In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19866 (EANDC(E)-157-U(Vol.1), pp 1-3;5) CAPTURE CROSS SECTIONS OF ^{54,57}Fe, ^{50,52,53}Cr, AND ^{62,64}Ni. Beer, H.; Spencer, R. R. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1973.

19867 (INS-593) REPORT ON THE WORK OF THE INSTITUTE OF NUCLEAR SCIENCES. Progress Report 20, July-December 1972. Rafter, T. A. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). Feb 1973. 109p. Dep. NTIS (U. S. Sales Only) $7.50.

Work in progress during the half-year July-December 1972, is reported. The following subject areas are included: nuclear physics, radiation research, isotope geochemistry-stable isotopes, radioactive dating and fallout, radioisotope applications and atmospheric trace gases, instrumentation, and theoretical physics. (3 figures, 3 tables) (RWR)

For title listings of selected papers see: 18234 and 19868.

19868 (INS-593, pp 12) ^{50}Ti(p,γ)^{51}V. McCallum, G. J.; Pohl, K. P. Feb 1973.

In report on the work of the Institute of Nuclear Sciences. Progress Report 20.

19869 (LIB/Trans-491) γ SPECTRUM GENERATED DURING THE CAPTURE OF THERMAL NEUTRONS BY NUCLEI OF ^{70,72,74}Ge. Barchuk, I. F.; Bazavov, D. A.; Belykh, G. V.; Golyohkin, V. I.; Murzin, A. V.; Ogorodnik, A. F. Translated from Ukr. Fiz. Zh. (Russ. Ed.); 15: No. 2, 245-250(1970). 8p. Dep. NTIS (U. S. Sales Only) $3.00.

An abstract of this article prepared from the original appeared as NSA, 24: 38190 (1970). (AT)

19870 EXCITED STATES OF ^{40}Ca UP TO 9 MeV. Tellez, A. (Univ., Orleans, France); Ronsin, H.; Ballini, R.; Fodor, I. J. Phys. (Paris); 34: No. 4, 281-293(Apr 1973). (In French).

The reactions ^{40}Ca(p,p'γ)^{40}Ca, ^{39}K(^{3}He,dγ)^{40}Ca, ^{36}Ar(^{7}Li,t)^{40}Ca, and ^{36}A(^{16}O,^{12}Cγ)^{40}Ca were observed for incident energies of 12, 18, 28, and 58 MeV, respectively. In this way, a systematic study of the electromagnetic branching ratios, lifetimes and the formation of excited ^{40}Ca states up to 9 MeV was possible. Simple criteria, which are applicable to all the levels studied, led to a classification of the ^{40}Ca states into four groups, each group having a well defined predominant structure. This classification, which is based, essentially, on qualitative arguments, is justified by the agreement between the experimental properties of the levels constituting a group and the theoretical predictions of models used to describe the group. (FR)

19871 MEASUREMENT OF MEAN LIVES IN THE ^{55}Fe NUCLEUS USING THE RECOIL-DISTANCE METHOD. Stoquert, J. P.; Chouraqui, G.; Muller, T.; Port, M.; Thirion, J. M. (CNRS, Strasbourg). J. Phys. (Paris); 34: No. 4, 295-299(Apr 1973). (In French).

The recoil-distance method was used to measure the mean lives of 3 excited states in the ^{55}Fe nucleus produced by the ^{52}Cr(α,nγ) ^{55}Fe reaction at 11 MeV. The results are given in ps: τ (931 keV) = 13.4 ± 4, τ (1316) = 26 ± 3.5, τ (1408) = 69 ± 7.5. Comparisons are made with results obtained using other methods and with theoretical predictions. (FR)

19872 POLARIZATION OF PROTONS INELASTICALLY SCATTERED BY ^{24}Mg, ^{52}Cr, AND ^{58}Ni. Ruh, A. W. Diss. Nr. 4434. Zurich; Eidgenoessische Technische Hochschule (1970). 56p. (In German).

Thesis.

The polarization of protons inelastically scattered by ^{24}Mg, ^{52}Cr, and ^{58}Ni, leaving the residual nucleus in its first excited state, was measured with a carbon polarimeter. Also, the polarization of the elastically scattered protons was measured. The energy of the incident protons was varied between 5.38 and 5.95 MeV; and the laboratory scattering angle, between 45° and 120°. In addition, the excitation functions were measured for ^{24}Mg(p,p$_1$)^{24}Mg* between 5 and 6 MeV and for ^{52}Cr(p,p$_0$)^{52}Cr, and ^{52}Cr(p,p$_1$)^{52}Cr* between 5 and 6.5 MeV. Large values of the polarization were determined for the protons scattered by ^{24}Mg, and, in agreement with the predictions of the statistical CN model, no polarization was observed for the protons inelastically scattered by ^{58}Ni. Relatively large polarizations were found in the inelastic scattering by ^{52}Cr; this result seems to indicate a violation of the statistical assumptions. The latter had been believed to be fulfilled, since (p,p'γ) angular-correlation measurements on ^{52}Cr had given excellent agreement with the statistical CN theory. On the other hand, the angular cross-correlation function of the cross-section fluctuations also does not agree with the statistical theory. The correlated intermediate structure of the excitation functions can probably be interpreted as an excitation of doorway states, which in turn would also explain the measured polarizations. (14 figures, 4 tables) (auth)

19873 TOTAL NEUTRON CROSS SECTIONS FOR THE TITANIUM, CHROMIUM, AND COPPER ISOTOPES. Dyumin, A. I.; Kaminker, D. M.; Popova, G. N.; Smolin, V. A. (Inst. of Nuclear Physics, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 4, 852-854(Apr 1972). (In Russian).

The author's earlier method was used to measure the total cross section of $^{46-50}$Ti, ^{50,52,53,54}Cr, and ^{63,65}Cu using TiO_2, Cr_2O_3, and Cu specimens. The following cross section values were obtained (σ_t in barns): ^{46}Ti, 2.45 ± 0.03; ^{47}Ti, 2.32 ± 0.05; ^{48}Ti, 2.49 ± 0.03; ^{49}Ti, 2.42 ± 0.04; ^{50}Ti, 2.39 ± 0.06; ^{50}Cr, 2.43 ± 0.03; ^{52}Cr, 2.45 ± 0.02; ^{53}Cr, 2.42 ± 0.03; ^{54}Cr, 2.54 ± 0.04; ^{63}Cu, 2.90 ± 0.03; ^{65}Cu, 2.96 ± 0.03. The indicated error reflects not only statistical fluctuations but the potential nonhomogeneity of the scatterer and uncertainty about the angle between the plane of the specimen and the direction of the beam, etc. The uncertainty of the absolute σ_t values is about 0.05 barn because the error in the separately measured cross section of oxygen is not included. The experimental data were clarified by introducing the isotopic dependence in the nuclear optical potential parameter. A formula was derived to describe the behavior of the total cross sections. It is suggested that the behavior of σ_t be confirmed experimentally in the A ~ 90 and A ~ 180 region. (TTT)

19874 ANOMALIES IN ELASTIC SCATTERING AT ISOBARIC ANALOGUE STATES. El-Kazzaz, S. A.; Abel Harith, M.; El-Nadi, L. M. (Cairo Univ.). Ann. Phys. (Leipzig); 28: No. 4, 315-320 (1973).

Excitation functions for proton elastic scattering by ^{55}Mn at proton energies from 1320 keV to 1480 keV were measured at the angles 135° and 150°. Anomalies in the differential elastic scattering were observed at E_p = 1350 ± 4 keV, 1385 ± 4 keV, and 1445 ± 4 keV. These resonance states are the isobaric analogs of the ground, first excited, and second excited states in ^{56}Mn respectively. Analysis of the results showed that these resonance states are best fitted to $J^{\pi} = 3^+$, 2^+, and 1^+, in excellent agreement with the J^{π} values of the corresponding states in ^{56}Mn. The total widths and proton widths of these states were determined. (4 figures, 2 tables) (auth)

19875 YIELD OF ^{44}Ti FROM THE IRRADIATION OF Sc BY PROTONS AND DEUTERONS. Dmitriev, P. P.; Molin, G. A.; Krasnov, N. N. At. Energ. (USSR); 34: No. 5, 404-405(May 1973). (In Russian).

The yields of ^{44}Ti were studied as functions of the bombarding particles, protons and deuterons, on a metallic Sc target up to maximum energies of ~22.5 MeV. Radiochemical separation of ^{44}Ti was required in the case of deuteron bombardment due to the reaction ^{45}Sc(d,p)^{46}Sc, but was unnecessary in the case of proton irradiation. At an energy of 22 MeV, for example, the ^{44}Ti yield from bombarding with protons was 0.040 μCi/μA · hr, or 2.7 times greater than that obtained from deuteron bombardment. (2 figures) (KSW)

19876 DETERMINATION OF THERMAL AND EPITHERMAL NEUTRON CROSS-SECTIONS OF VANADIUM ISOTOPES. Vertebnyi, V. P.; Vlasov, M. F.; Gnidak, N. L.; Zatserkovskii, R. A.; Ignatenko, A. I.; Kirilyuk, A. L.; Pavlenko, E. A.; Trofimova, N. A.; Fedorova, A. F. At. Energ. (USSR); 34: No. 5, 355-358 (May 1973). (In Russian).

The energy dependence of the total neutron cross section of

natural vanadium was measured on the WWR-M reactor of the Nuclear Research Institute, Ukrainian Academy of Sciences, in the energy range 0.007 to 110 eV by using the time-of-flight method. The energy dependence of the total neutron cross section of the rare odd–odd isotope of ^{50}V was measured in the energy range 0.007 to 1.7 eV. The scattering cross sections of natural vanadium and ^{50}V were measured in 4π geometry in the energy range 0.5 to 5 eV. The scattering cross sections of natural vanadium are compared with the scattering cross sections of reactor graphite and bismuth of high purity. For natural vanadium at v = 2200 m/s, the following values were obtained: total cross section τ_t = (10.06 ± 0.03) barn, capture cross section τ_a = (5.28 ± 0.03) barn, scattering cross section τ_s = (4.75 ± 0.03) barn. At this point, for ^{50}V, the total neutron cross section = (48 ± 4) barn, capture cross section τ_a = (41 ± 4) barn, and scattering cross section τ_s = (7.5 ± 1) barn. The scattering cross sections of bismuth and graphite, which are in agreement with the scattering cross sections of natural vanadium, equal 9.29 barn and 4.74 barn, respectively. (2 figures, 5 tables, 16 references) (auth)

19877 PROPOSED $K^\pi = 0^-$ BAND IN ^{44}Sc. Dracoulis, G. D.; Durell, J. L.; Gelletly, W. (Univ. of Manchester, Eng.). J. Phys., A (London); 6: No. 7, 1030-1036(Jul 1973).

The lifetimes and spins of the low-lying negative parity states of ^{44}Sc have been determined. The spin sequence 1^-, 2^-, 3^-, 4^- and possibly 0^- assigned to the 68, 235, 425, 631 and 146 keV states, together with the measured transition strengths, suggest that these states are members of a $K^\pi = 0^-$ band based upon a $d_{\frac{3}{2}}$ hole configuration. (auth)

19878 $1f_{\frac{7}{2}}$ NUCLEI. Gamma Ray Spectroscopic Studies on States in ^{53}Mn and ^{53}Fe Using the ^{50}Cr + α Reaction. Sawa, Z. P. Phys. Scr.; 7: No. 1-2, 5-23(1973).

The structures of ^{53}Mn and ^{53}Fe with emphasis on high spin states have been investigated by coincidence, yield, angular distribution, and linear polarization measurements of gamma rays from the ^{50}Cr + α reaction at E_α = 14.2 MeV. States assigned: in ^{53}Mn: 377 keV (confirmed), 1,289 keV $\frac{3}{2}^-$ (confirmed), 1,441 keV $\frac{11}{2}^-$ (confirmed), 1,621 keV $\frac{9}{2}^-$ (confirmed), 2,564 keV $\frac{13}{2}^-$, 2,693 keV $\frac{15}{2}^-$, 2,697 keV $\frac{11}{2}^-$, 3,426 keV $\frac{13}{2}^-$, and 3,440 keV $\frac{17}{2}^-$; in ^{53}Fe: 742 keV $\frac{3}{2}^-$, 1,328 keV $\frac{9}{2}^-$ (confirmed), 1,424 keV $\frac{5}{2}^-$, 1,697 keV $\frac{7}{2}^-$, 2,339 keV $\frac{11}{2}^-$ (confirmed), 3,041 keV $\frac{19}{2}^-$ (confirmed), 3,176 keV $\frac{13}{2}^-$, 3,463 keV $\frac{15}{2}^-$ and tentatively (4,813 keV $\frac{17}{2}^-$). Comparison is made with the cross conjugate nuclei within the $1f_{\frac{7}{2}}$ shell ^{43}Ca and ^{43}Sc. Feasibility of assignments of residual states in reactions induced by alpha beams of moderate energies is briefly discussed. (auth)

19879 SYSTEMATICS OF NUCLEAR LEVEL DENSITY PARAMETERS OF NUCLEI DEFICIENT IN ONE NEUTRON. Barrett, R. F.; Birkelund, J. R.; Thomas, B. J.; Lam, K. S.; Thies, H. H. (Univ. of Western Australia, Nedlands). Nucl. Phys., A210: No. 2, 355-379(1973).

Photoneutron mean energies of 38 elements were measured as a function of peak bremsstrahlung energy for elements with $23 \leq Z \leq 83$. Results are compared with neutron mean energies calculated from statistical theory, using for nuclear level densities modified Fermi gas formulas with and without pairing corrections and a constant temperature formula. Except near closed shells the Fermi gas formula with pairing corrections gives reasonable to good correlation between experimental and theoretical data. Derived values of the nuclear level density parameter a—except near Z = 82—are in quantitative agreement with those from recent neutron resonance data. (auth)

19880 SHORT-RANGE CORRELATIONS IN ONE- AND TWO-NUCLEON TRANSFER REACTIONS. Osman, A. (Cairo Univ.). Particles Nucl.; 4: No. 5-6, 209-230(1972).

Short-range correlations between nucleons in the nuclear reactions are considered. One- and two-nucleon transfer reactions as the (d,p), (p,d), (t,p) and (p,t) nuclear reactions are considered. Referring to the (t,p) stripping reactions the introduction of a repulsive-core for the two-nucleon interactions was investigated where it was found that it is of negligible effect. In spite that, taking into account the short-range effects, the DWBA calculations of the angular distributions for these reactions well agree the experimental results. Introducing the repulsive core effects together with the finite-range effects, the DWBA calculations of the differential cross section, taking for example the (t,p) stripping reactions, result in extracting the correct spectroscopic factors. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 19837, 19847, 19866, 19873, 19879, 19880, 19893, 19922, 19923, 19935, 19955, and 20002.

19881 (ANU-P-570) PLACEMENT OF THE 188 keV TRANSITION IN ^{70}Ga. Carlson, L. E.; Najam, M. R.; Davidson, W. F.; Biggerstaff, J. A.; Martin, P. W. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1970. 18p. Dep. NTIS (U.S. Sales Only) $3.00.

A careful study of the γ-rays following the ^{70}Zn(p,nγ)^{70}Ga reaction has shown no evidence for the introduction of a first excited state at 188 keV in ^{70}Ga. A 188 keV γ-transition, however, was found to deexcite the 879 keV level in ^{70}Ga, whose half-life was measured to be 24 ± 3 ns. (6 figures) (auth)

19882 (ANL-P-571) SPINS OF LEVELS IN ^{70}Ga. Najam, M. R.; Carlson, L. E.; Davidson, W. F.; Zuk, W. M. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1973. 38p. Dep. NTIS (U.S. Sales Only) $4.00.

The level structure of the nucleus ^{70}Ga has been studied by means of the ^{70}Zn(p,n)^{70}Ga reaction (Q = −1.435 MeV). Levels in ^{70}Ga up to 1,633 keV in excitation were selectively populated by varying the proton bombarding energy in the range of 1.7 to 3.2 MeV. The γ-rays associated with these levels were identified in singles spectra from their energies and their threshold behavior. Gamma-ray branching ratios were obtained, and a decay scheme for ^{70}Ga comprising 58 transitions is presented. Angular distributions of de-exciting γ-rays have been measured at proton bombarding energies close to threshold for the levels studied. Comparison of these distributions with the theoretical predictions of the compound nucleus statistical model has led to spin and parity assignments for the levels studied. (4 figures, 3 tables) (auth)

19883 (CONF-700705–(Vol.2), pp 837-841) NUCLEI–NUCLEI INTERACTIONS AT SMALL IMPACT PARAMETERS. Gagarin, Yu. F.; Ivanova, N. S.; Kulikov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). 1970.

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Interactions of heavy primaries with nuclei of nuclear emulsions were investigated as a function of the target mass. The emulsion stack was exposed aboard satellite. The average characteristics of the interactions and the angular distributions were studied. Nucleus–nucleus interactions involving total disintegration of the target nucleus occur with a small impact parameter. Analysis of the results shows that in collisions with $N_h \geq 28$ the total disintegration of the nucleus appears to be a one-stage process. In addition, the peculiarities of nucleus–nucleus collisions indicate that the effects of many-particle interactions and the decrease of nucleon density reveal themselves considerably stronger in nucleus–nucleus collisions than in nucleon–nucleus interactions. (1 figure, 1 table) (RWR)

19884 (COO-3239-6, pp 8-10) REACTIONS OF COPPER WITH PROTONS AT 200 AND 300 GeV. Yester, M. V. Jun 1973.

In nuclear chemistry research of high energy nuclear reactions at Carnegie–Mellon University.

19885 (PEL-191) SCATTERING OF FAST NEUTRONS FROM RUBIDIUM AND CESIUM. Coetzee, N. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Oct 1969. 84p. (In Afrikaans). INIS.

The level schemes of the nuclei ^{85}Rb, ^{87}Rb and ^{133}Cs were studied by means of inelastic and elastic neutron scattering in the energy range 240–1250 keV. Total cross sections were measured over the same energy range. The Van de Graaff accelerator of the AEB was used to produce a pulsed proton beam. Neutrons were generated by the Li(p,n) and T(p,n) reactions. The scattering samples were solid right cylinders and were canned in stainless steel cans with thin walls. The samples consisted of natural Cs metal and the natural isotopic mixture of Rb. Scattered neutrons were observed with a time-of-flight spectrometer, using flight paths between 0.7 and 2.2 meters. Excitation of at least four levels in ^{85}Rb, two in ^{87}Rb and eight in ^{133}Cs, was observed. (n,n'γ) measurements were used to determine the energies of these levels fairly accurately. Not all of these levels had previously been reported. Excitation functions for scattering from all these levels were measured. Hauser–Feshbach calculations were performed to determine the spin and parity values of the newly detected levels. Some calculations indicated a doublet structure, in which case it was impossible to determine spin and parity values for the level(s). The transmission coefficients used in the Hauser–Feshbach calculations were obtained from an optical model for which the parameters were determined by fits to the data on elastic scattering, and to the data on inelastic scattering from levels of known spin and parity. In the small area of possible comparison, fair agreement exists between this work and previous measurements. (104 references) (INIS)

19886 DE-EXCITATION OF EVEN–ODD NUCLEI OF GERMANIUM AFTER THERMAL NEUTRON CAPTURE. Groshev,

L. V.; Govor, L. I.; Demidov, A. M. (Inst. of Atomic Energy, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 4, 833-841 (Apr 1972). (In Russian).

The extracted thermal neutron beam of the IRT-M reactor, passed through quartz and bismuth single crystals, was used for the measurements, the γ radiation being recorded by a Ge(Li) detector. The enriched ^{70}Ge specimen used for the experiments contained several other Ge isotopes. The level schemes of the isotopes ^{71}Ge, ^{73}Ge, ^{75}Ge, and ^{77}Ge are presented, indicating the energies of the excited states. In the ^{71}Ge nucleus very strong M1 transitions take place, such as E_γ = 5451.9 keV (1.43%) at the 1965.4 keV, $1/2^+$ level. For ^{73}Ge, the level scheme from the (nγ) and levels from the (dp) reactions are presented. In case of ^{75}Ge and ^{77}Ge, no previous data on radiative neutron capture have been available; the new level scheme data refer to levels excited by (nγ) and (dp) reactions. Study of ^{77}Ge was complicated by the γ lines of ^{76}Ge and by the absence of ^{77}Ge lines in the spectrum of the natural mixture. (TTT)

19887 INELASTIC SCATTERING OF SLOW NEUTRONS BY NICKEL SPECIMENS OF DIFFERENT ISOTOPIC COMPOSITION. Gorbachev, B. I.; Ivanitskii, P. G.; Krotenko, V. T.; Pasechnik, M. V. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 18: No. 4, 558-564(Apr 1973). (In Russian).

Inelastic scattering cross sections of slow neutrons by polycrystalline specimens of nickel with the natural isotopic mixture, with the incoherent scattering isotopic mixture and with the isotopic mixture enriched by isotope ^{62}Ni to ~95% were measured with high statistical accuracy. The functions g(ΔE) of these specimens were derived from these cross sections and compared. The influence of coherent effects on accuracy of the function g(ΔE) derivation of the coherent scatterers in the incoherent approximation and the influence of isotopic components on the function g(ΔE) are discussed. (auth)

19888 YIELDS OF ^{72}Se AND ^{75}Se IN NUCLEAR REACTIONS WITH PROTONS, DEUTERONS, AND α-PARTICLES. Dmitriev, P. P.; Molin, G. A.; Konstantinov, I. O.; Krasnov, N. N.; Panarin, M. V. At. Energ. (USSR); 34: No. 5, 405-406(May 1973). (In Russian).

The yields of ^{72}Se and ^{75}Se were measured as functions of the energy of the bombarding particles on specified isotopes of As and Ge up to a maximum energy of 22 MeV/charge. Yields for the six nuclear reactions, in μCl/μA · hr, were 52 for ^{75}As(p,n)^{75}Se at 22 MeV, 77 for ^{75}As(d,2n)^{75}Se at 23 MeV, 33 for ^{70}Ge(α,2n)^{72}Se at 44 MeV, and 8 for the three reactions at 44 MeV: ^{72}Ge(α,n)^{75}Se, ^{73}Ge(α,2n)^{75}Se, and ^{74}Ge(α,3n)^{75}Se. (1 figure, 1 table) (KSW)

19889 HALF-LIFE OF ^{88}Zr. Stanovnik, A.; Pucelj, B. (Univ. of Ljubljana, Yugoslavia). Radiochem. Radioanal. Lett.; 14: No. 4, 273-275(30 Jul 1973).

The half-life of ^{88}Zr was measured directly by following the decay of the 0.394-MeV gamma ray activity. A value of 83.4 ± 0.3 days was obtained. (1 figure) (auth)

19890 LOW ENERGY GAMMA TRANSITIONS IN THE DECAY OF ^{75}Se. Thomas, R. N.; Thomas, R. V. (Bedford Coll., London). J. Phys., A (London); 6: No. 7, 1037-1040(Jul 1973).

The gamma spectrum from the decay of ^{75}Se has been studied using Ge(Li) detectors and coincidence techniques. An 81 keV transition has been observed for the first time in the gamma spectrum and, together with a 24 keV transition, has been reliably measured and placed in the decay scheme. Some evidence is found for a previously unreported transition of energy 15 keV, but the present investigation provides no support for the existence of transitions of energy 469 and 822 keV reported in another Ge(Li) study of this decay. (auth)

19891 LOW-LYING STATES OF ^{62}Zn IN ^{64}Zn(p,t)^{62}Zn AND ^{63}Cu(p,2nγ)^{62}Zn REACTIONS. Kusakari, H.; Suehiro, T.; Ishihara, M.; Kawakami, H.; Yoshikawa, N. (Tokyo Univ.). J. Phys. Soc. Jap.; 34: No. 4, 865-873(Apr 1973).

Excited levels of ^{62}Zn were studied by means of the (p,t) reaction at 51.9 MeV and in-beam gamma-ray spectroscopy using the ^{63}Cu(p,2nγ)^{62}Zn reaction. The triton angular distributions in ^{64}Zn (p,t)^{62}Zn and the gamma-ray spectra in ^{63}Cu(p,2nγ)^{62}Zn were obtained. Twenty excited levels up to 5.56 MeV of ^{62}Zn were observed at the excitation energies of 0.954, 1.805, 2.186, 2.38, 2.75, 2.80, 3.22, 3.44, 3.78, 3.93, 4.00, 4.16, 4.32, 4.60, 4.75, 4.86, 5.02, 5.09, 5.40 and 5.56 MeV. The excited states at 0.954, 1.805, 2.186, 2.38, 3.22, 3.44, 3.93, 4.32 and 5.02 MeV were concluded to have J^π of 2^+, 2^+, 4^+, 0^+, 3^-, 2^+, 0^+, 3^- and 4^+, respectively. The branching ratio in the decay of the second 2^+ state was determined as $I(2_2^+ \rightarrow 2_1^+)/I(2_2^+ \rightarrow 0_{g.s.}^+) = 60/40$. The nuclear properties of the low-lying states of ^{62}Zn are discussed in detail in comparison with other nuclei in this region. (auth)

19892 ELASTIC AND INELASTIC SCATTERING OF 18.6 MeV PROTONS BY ^{68}Zn, ^{90}Zr, AND ^{114}Cd. Tweeton, D. R. Minneapolis; Univ. of Minnesota (1973). 151p. University Microfilms Order No. 73-18,156.

Thesis (Ph. D.).

Differential cross sections for elastic and inelastic scattering of 18.6 MeV protons by ^{68}Zn, ^{90}Zr, and ^{114}Cd were measured over an angular range of 20 to 165°. The optical model was used to fit the elastic data, which are generally of 1 per cent relative accuracy. Both DWBA and coupled-channels calculations were used in fitting the inelastic cross sections, which are for the collective one-phonon quadrupole (2^+) and the one-phonon octupole (3^-) vibrational states and are generally of 3 to 10 per cent accuracy. The two approaches gave similar fits. The rotational collective model gave a better fit for the 2^+(.556 MeV) state of ^{114}Cd than did the vibrational model. The effect of the coupling scheme and the effect of allowing the imaginary strengths for the inelastic channels to be different from that for the elastic channels were investigated. It was found that both of these affect the calculated deformations of the inelastic states, and that together they can yield an uncertainty of 25 per cent or more in the deformations, i.e., nearly equivalent fits can be obtained with deformations differing by 25 per cent. The effect of the imaginary geometry on the inelastic angular distributions also was investigated and it was found that the imaginary strength W_D and the imaginary diffuseness a_I can act together in such a way that as W_D is decreased and a_I is increased, predicted inelastic cross sections are decreased at backward angles and increased at forward angles. (Diss. Abstr. Int., B)

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Refer also to abstracts 18074, 19824, 19829, 19837, 19847, 19879, 19880, 19885, 19892, 19955, 19959, 20002, and 20228.

19893 (AAEC/E-277) COMPILATION OF S AND P WAVE NEUTRON STRENGTH FUNCTION DATA. Musgrove, A. R. de L (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1973. 33p. Dep. NTIS (U.S. Sales Only) $3.75.

A compilation of experimental data on s- and p-wave neutron strength functions has been made to bring up to date an earlier survey of K. K. Seth (1966). The data are presented in tabular form with recommended values. (2 figures, 1 table) (auth)

19894 (AD-758878) EXPERIMENTAL PROGRAMS WITH THE BRL TANDEM VAN de GRAAFF AND COCKCROFT-WALTON ACCELERATORS. Annual Progress Report, 1 March 1971-29 February 1972. Eccleshall, D.; Van Antwerp, W. R. (Ballistic Research Labs., Aberdeen Proving Ground, MD). Mar 1973. 117p. (BRL-MR-2279). NTIS.

An additional year of investigations with the BRL Tandem Van de Graaff and Cockcroft-Walton accelerator facilities has been completed. Research has been continued in many areas, and this report describes the status of experiments in progress. It also indicates actual or planned research in areas where results have not yet been obtained. Studies in neutron physics, neutron production and cross section measurements, charged-particle and heavy-ion reactions, gamma-ray decay and polarization, delayed-fission isomers, radiation chemistry, and radiation physics are discussed. During the year, a substantial effort has been continued at both accelerators for facility development. These additions to the facility capabilities are described in some detail for the benefit of potential users and for staff reference. Information is also provided on accelerator performance, personnel, publications, and cooperative programs with universities and with other Army researchers. (auth)

19895 (AEC-tr-7448) STUDY OF THE LEVEL SCHEME OF ^{93}Nb BY MEASUREMENT OF THE GAMMA-RAYS EMITTED AFTER INELASTIC SCATTERING OF FAST NEUTRONS. Goebel, H.; Feicht, E. J.; Vonach, H. Translated from Z. Phys.; 240: 430-453(1970). 22p. Dep. NTIS $3.25.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 17902.

19896 (CEA-N-1600, pp 204-205) STUDY OF NUCLEI IN THE A = 115 REGION AND THE BEHAVIOR OF THE GIANT RESONANCE AS A FUNCTION OF A. (CEN de Saclay, Gif-sur-Yvette, France). 1972. (In French).

An experimental investigation of the variation of the giant dipole resonance as a function of A is presented. Closed-shell nuclei show a definite narrowing of the giant dipole resonance. (FR)

19897 (CEA-R-4428) STUDY OF THE DECAY OF ^{137}Cs + ^{137m}Ba. Legrand, J.; Brethon, J. P.; Lagoutine, F. (Commis-

sariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1973. 15 p. (In French). Dep. NTIS (U.S. Sales Only $3.00.

Some parameters of the $^{137}Cs + ^{137m}Ba$ decay schemes were measured accurately, particularly, the half-life of ^{137m}Ba (2.5545 ± 0.0021 min) and the internal conversion coefficients α_K (0.0901 ± 0.0009) and α_t (0.1105 ± 0.0010). The 661-keV photon number per ^{137}Cs decay is 0.853 ± 0.008. (4 tables) (auth)

19898 (COO-3239-6) NUCLEAR CHEMISTRY RESEARCH OF HIGH ENERGY NUCLEAR REACTIONS AT CARNEGIE-MELLON UNIVERSITY. Annual Progress Report, 1972-1973. Caretto, A. A. Jr. (Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Chemistry). Jun 1973. Contract AT(11-1)-3239. 23p. Dep. NTIS $3.25.

Research between June 1, 1972, and May 31, 1973, is described, along with the facilities used and a list of publications. Work was concentrated on high-energy reactions and heavy-ion reactions. Several abstracts from theses or journal articles are given. Reactions of light nuclei with π^+ and π^- at 190 MeV; reactions of Cu with p at 200 and 300 GeV; isobaric yields from reactions of 720 MeV alpha particles with $^{92,96,100}Mo$; and alpha-induced simple nuclear reactions are discussed at greater length. (RWR)

For title listings of selected papers see: 19884 and 19899.

19899 (COO-3239-6, pp 13-15) STUDY OF ALPHA-INDUCED SIMPLE NUCLEAR REACTIONS. Yates, M. A. Jun 1973.

In nuclear chemistry research of high energy nuclear reactions at Carnegie-Mellon University.

19900 (COO-3274-8, pp 5-10) LINEAR POLARIZATION OF GAMMA RAYS FROM HEAVY-ION REACTION. Kim, J. S.; Lee, Y. K. 1973.

In nuclear moments and nuclear structure.

19901 (COO-3496-29, pp 55-60) MECHANISMS OF (p,p') REACTIONS ON THE HEAVY TIN ISOTOPES. Kalbach-Cline, C.; Huizenga, J. R.; Vonach, H. K. 1973.

In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19902 (INR-1410) INSTITUTE OF NUCLEAR RESEARCH TWO-YEAR-BOOK, 1970-1971. (Institute of Nuclear Research, Warsaw (Poland)). 1972. 283p. Dep. NTIS (U.S. Sales Only) $16.25.

The material is presented according to the following arrangement: nuclear physics (nuclear reactions, nuclear spectroscopy and fission, physics of high energy and elementary particles, nuclear methods in solid state physics, high-temperature plasma physics, instrumentation for nuclear physics), nuclear chemistry (radiation chemistry, the chemistry of radioelements, analytical chemistry, chemistry and technology of fuel materials), reactor engineering (nuclear power problems, reactor engineering, reactor physics, fuel cycle), health physics (radiation protection, radiobiology and health protection), application of isotopes and nuclear physics methods (technology of radioisotopes, applications of nuclear techniques in industry, measuring-control equipment based on employment of ionizing radiation), and high-temperature technology (magnetohydrodynamic generators, plasma high-temperature technology). Although some data are shown, the report is basically descriptive in nature. The material presented, especially the research items, are highly referenced. (RWR)

19903 (JAERI-M-4930) GAMMA-RAY SPECTRA OF THE FPs (FPDATA-2). Sasamoto, N.; Tasaka, K. (Japan Atomic Energy Research Inst., Tokyo). Aug 1972. 77p. NTIS (U. S. Sales Only).

Over 300 radioactive nuclides are produced by the fission of a fuel material, and these emit γ-rays of different energies. Their half-lives vary widely, so the γ-ray spectrum due to FP's differs in a complex manner with the irradiation and cooling times. To measure the particular γ-ray from a particular nuclide with high accuracy, the irradiation and cooling behavior of the γ-ray spectrum must be observed closely. It is then desirable to calculate the γ-ray spectra and thereby anticipate the experimental results, especially in the case of a long cooling time required or a short cooling time permitted. The γ-ray spectra from FP's were calculated with irradiation and cooling times as the parameters, assuming a Ge(Li) detector for γ-ray detection; the results are given in tables and figures. The energy resolution (fwhm) of the detector is constant at 4 keV, independent of the photon energy. The number of nuclei for each FP is calculated analytically by using Bateman's equation and its integral form repeatedly, with thermal-neutron fission yields of ^{235}U. Compton effects and characteristic x rays are omitted in the calculation. (auth)

19904 (LA-5253-MS) COMPILATION OF REQUESTS FOR NUCLEAR DATA. Stewart, L.; Moore, M. S.; Motz, H. T. (comps. and eds.). (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 334p. (USNDC-6). Dep. NTIS $10.60.

For U. S. Nuclear Data Committee.

This report contains a list of requests for cross-section and other measurements important to the U. S. nuclear energy program. They have originated from various A.E.C. agencies, contractors, and others. Priorities for the various measurements are given. (RWR)

19905 (ORO-4282-7) NUCLEAR CHEMISTRY. Annual Progress Report. Kuroda, P. K. (Arkansas Univ., Fayetteville. Dept. of Chemistry). 31 Jul 1973. Contract AT(40-1)-4282. 46p. Dep. NTIS $4.50.

Nuclear chemistry research in nuclear spectroscopy, the pre-Fermi (natural) nuclear reactor, and solar temperature is briefly described, along with associated instrumentation. More detailed reports on the research were prepared for journal publication. (RWR)

19906 (UUIP-806) EXCITED STATES IN ^{103}Pd STUDIED THROUGH THE $^{103}Rh(p,n\gamma)$ AND $^{103}Rh(d,2n\gamma)$ REACTIONS AND THE ^{103}Ag DECAY. Nyman, B.; Dietrich, W.; Johansson, A.; Lannergard, C. O.; Baecklin, A.; Pettersson, H. (Uppsala Univ. (Sweden). Inst. of Physics). Mar 1973. 37p. Dep. NTIS (U.S. Sales Only) $4.00.

The level scheme of ^{103}Pd has been investigated by means of gamma-ray and internal conversion measurements in the $^{103}Rh(p,n\gamma)$ and $^{103}Rh(d,2n\gamma)$ reactions and the ^{103}Ag decay. On basis of extensive on-line and decay γγ-coincidence measurements a revised and much enlarged ^{103}Pd level scheme containing 43 levels has been constructed. Tentative spin-parity assignments, derived from relative excitation functions, transition multipolarities and log ft values, have been given for the majority of the 25 levels observed in the reactions. (auth)

19907 (UUIP-816) TRANSITION RATES IN ^{97}Tc. Bergman, C.; Svahn, B.; Svensson, L. G.; Baecklin, A.; Lindskog, J. (Uppsala Univ. (Sweden). Inst. of Physics). Mar 1973. 14p. Dep. NTIS (U. S. Sales Only) $3.00.

The deexcitation of the 215 keV $^7/_2{}^+$ and the 324 keV $^5/_2{}^+$ levels in ^{97}Tc, as observed in the ^{97}Ru decay, was studied by means of internal conversion electron spectroscopy and delayed electron-electron coincidence techniques. From L-subshell intensity ratios the E2 content in the 108 and 215 keV transitions were found to be (65 ± 12)% and (7 ± 4)%, respectively. The obtained level lifetimes were 0.75 ± 0.09 ns for the 324 keV level and 94 ± 15 ps for the 215 keV level. (auth)

19908 DIFFERENTIAL RECOIL AND ANGULAR DISTRIBUTION STUDY OF SEVERAL (p,pxn) AND (p,xn) REACTIONS OF ^{133}Cs WITH 550-MeV PROTONS. Molecke, M. A. Pittsburgh; Carnegie-Mellon Univ. (1973). 161p. University Microfilms Order No. 73-13,940.

Thesis (Ph.D.).

Differential range and angular distributions of the recoil nuclei produced from the $^{133}Cs(p,pn)$, (p,p4n), (p,3n), and (p,6n) reactions at 550 MeV were measured in order to determine quantitatively the proportions of several nuclear mechanisms occurring. Two-body proton-nucleon kinematic calculations simulating the initial cascade portion of the Inelastic Scattering plus Evaporation or Charge Exchange Scattering plus Evaporation mechanisms were performed. Nuclear recoil angles based on this calculational model were in very good agreement with observed peaking in the experimental angular distributions. The remainder of the experimental distribution, minus the observed transverse peaking, was attributed to a Clean (or possibly Unclean) Knock Out-type mechanism. Differential ranges (thin target-thin catcher technique) of the recoil nuclei were measured at 0° ± 30° and 90° ± 30° relative to the incident proton beam, as well as over a 2π geometry, in order to determine the relative amounts of energy or momentum transferred to the nucleus via different mechanisms. Results were compared with extensions of the two-body kinematic-model calculations. Correlation of the differential recoil range and angular distribution data illustrated the compatibility of the mechanistic approach taken. Also measured radiochemically were the $^{133}Cs(p,pxn)^{133-x}Cs$ and $^{133}Cs(p,xn)^{134-x}Ba$ cross sections at 550 MeV, with values for x extending up to ten, noninclusively. These data, as well as angular distribution and differential recoil range results, were compared with the results of Monte Carlo computations using the VEGAS program (STEPNO version), which simulates the high-energy cascade phase of the Serber model, and the EVAP program, which simulates the statistical nucleon evaporation phase of the reaction model. Agreement with the experimental data ranged from good to limited in most cases. (RWR)

19909 MECHANISMS OF HIGH-ENERGY NUCLEAR REACTIONS. Baechmann, K.; Neidhart, B.; Ross, E. (Technische

Hochschule, Darmstadt, Ger.). Radiochim. Acta; 18: No. 3, 133-137(1972). (In German).

Conclusions as to the mechanism of formation are drawn from the recoil properties of products of the interaction of high-energy protons with complex nuclei. The discussion is based upon data obtained by the authors (tantalum with 300-MeV, 580-MeV, 19-GeV protons) and data from the literature. For spallation products a linear dependence on $\sqrt{\Delta A}$ is proved for the pulses. It is not possible with the data at hand to distinguish between nucleons knocked out and nucleons evaporated. However, the so-called F/B ratio can be used to draw conclusions on the fraction of the fast cascade as a function of proton energy. For products of mean mass it must be assumed that fission, spallation, and fragmentation contribute to the process of formation. (6 figures, 1 table) (auth)

19910 GAMMA–GAMMA ANGULAR CORRELATION OF A 328 TO 487 keV CASCADE OF ^{140}Ce IN LANTHANUM OXYTUNGSTEN OXIDE. Georgieva, M.; Misheva, M.; Tumbev, G. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 23: 127-133(1973). (In Bulgarian).

The integral gamma–gamma angular correlation of a 328–487 keV cascade of $^{140}_{58}Ce_{82}$ in lanthanum oxitungstenoxyde ($La_2O_3 \cdot WO_3$) is investigated with three different methods: single crystal with axis C perpendicular to the plane formed from the axes of the detectors; single crystal with axis C in the plane formed from the axes of the detectors; polycrystalline lanthanum oxitungstenoxyde. The radioactive sources were obtained from irradiation of the $La_2O_3 \cdot WO_3$ with thermal neutrons from the IRT-2000 reactor. The quadrupole coupling determined by means of the three methods for the assumption of axial symmetry of the single crystal and static quadrupole interaction is as follows: (690 ± 150) MHz, 540 MHz, and (540 ± 60) MHz. (3 figures, 1 table) (auth)

19911 STUDY OF LOW-SPIN NUCLEAR STATES IN THE VIBRATIONAL NUCLEUS ^{106}Pd. Ardisson, G.; Marsol, C. (Institut d'Etudes Nucleaires, Algiers). Compt. Rend., Ser. A, B; 276: No. 13, 563-565(26 Mar 1973). (In French).

A level scheme is presented for ^{106}Pd. The scheme consists of 38 excited states, the existence of six of these states (2755.6, 2788.9, 2997.7, 3150.8, 3252.5, and 3274.9 keV) being proposed for the first time. (FR)

19912 STRUCTURE OF THE LOW-LYING LEVELS OF THE NUCLEI ^{93}Tc AND ^{91}Nb. Isakov, V. I.; Kozhamkulov, T. A.; Guman, V. N. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 4, 848-851 (Apr 1972). (In Russian).

According to the shell model the ^{93}Tc nucleus possesses three valence protons at the $1g_{9/2}$ level; its lower levels have positive parity and the nucleus belongs to the $\{(1g_{9/2})^3\}$ three-particle configuration. The ^{91}Nb nucleus has one valence proton at that level, but two protons from the $2p_{1/2}$ level may be excited to the $1g_{9/2}$ level, thus also yielding a $\{(1g_{9/2})^3\}$ type three-particle configuration. In view of the similarity of the residual interactions in the two nuclei, the spallation of the levels is also expected to be similar. In the calculations it was assumed that the ratio of Wigner and singlet forces is about 3:2, i.e., the same as around lead and that the contribution of tensor forces is low. The results indicated that the $\{(1g_{9/2})^3 \nu = 3, I = 9/2\}$ level is practically pure to an accuracy of 10^{-6} and does not mix with other levels. The mixture coefficient α is equal to 0.76. If the interaction between configurations is taken into account, the above state is lowered; however, selection of the residual force values which correctly described the spectrum of ^{93}Tc did not yield the correct sequence of the lower two levels of the ^{91}Nb nucleus. A formula is given concerning the matrix elements of Eλ transitions between the levels of ^{93}Tc and the pure, positive-parity levels of the ^{91}Nb nucleus. (TTT)

19913 ANNIHILATION EXPLOSION AS A POSSIBLE CAUSE OF ISOTOPIC ANOMALIES ON THE EARTH. Vlasov, N. A. At. Energ. (USSR); 34: No. 5, 395-396(May 1973). (In Russian).

The possibility of antimatter such as a meteor colliding with the Earth with a resulting annihilation explosion and accompanying nuclear transformations is explored. Neutrons of annihilation origin are more energetic than fission neutrons, and π mesons would be given off by an annihilation process in addition to fast neutrons. The existence and natural abundance of certain Nd isotopes are attributable to the fissioning of U; on the other hand, the anomalous abundance of ^{138}La of only 0.089% in natural La must be explained by other causes. Annihilation explosions might account for this and similar anomalies. (KSW)

19914 THEORY AND INTERPRETATION OF MAGNETIC RESONANCE SPECTRA. Dixon, W. T. London; Plenum Press (1972). 170p.

The subject is dealt with in sections: introduction and basic theory for a particle in a field; elements of quantum theory; the observation of magnetic resonance; parameters obtained from magnetic resonance spectra; theory of chemical shifts and g-values, and the influence of electronic orbital angular momentum on the position of resonance (expressions for the magnetic interactions, g-values and chemical shifts in atoms, quenching of orbital angular momentum, the effects of spin–orbit coupling, the effective spin Hamiltonian, predictions of g-factors and chemical shifts, proton chemical shifts); the theory of coupling constants (hyperfine splitting in ESR spectra, molecular orbital theory of coupling constants in free radicals, the valence-bond theory of coupling constants, spin polarization, negative spin density, anisotropic coupling constants in solids, nuclear spin–spin coupling in solution, valence bond theory of proton coupling constants, molecular orbital theories of coupling constants); time-dependent effects in magnetic resonance (consequences of Brownian motion, nuclear quadrupole relaxation, effects of changing environment of a spin-interchange between two types of position, double resonance, electron–nuclear double resonance). (UK)

19915 COUPLED-CHANNEL BORN-APPROXIMATION CALCULATION OF THE REACTION ^{100}Mo(t,p)^{102}Mo. Yamaji, S. (Inst. of Physical and Chemical Research, Wako, Japan). J. Phys. Soc. Jap.; 34: No. 2, 298-303(Feb 1973).

The transitions to the ground state and the first 2+ state in the reaction ^{100}Mo(t,p)^{102}Mo were calculated in the coupled-channel Born approximation (CCBA). The calculations of the microscopic spherical phonon model and the deformed model were carried out for the structure of the nuclei ^{100}Mo and ^{102}Mo. The inelastic process was treated macroscopically for both models. The results of the two models were compared. Concerning the ratio of the cross section of the ground state to that of the first 2+ state, the spherical phonon model is preferable to the deformed model. In order to see the change of angular distribution and magnitude of the direct and indirect transitions to the first 2+ state due to the variation of the coupling parameter and to examine the validity of the DWBA treatment of the inelastic process numerically, model calculations were performed with the form factor obtained by assuming two-neutron $(g_{7/2})^2$ configuration in the Woods-Saxon well for the states of ^{102}Mo. (auth)

19916 ABSOLUTE MEASUREMENT OF THE ENERGY OF α PARTICLES EMITTED BY ^{148}Gd. Gorman, D. J.; Michel, H. V.; Asaro, F.; Rytz, A. (Bureau International des Poids et Mesures, Sevres, France). Compt. Rend., Ser. A, B; 276: No. 15, 669-671 (9 Apr 1973). (In French).

The mean energy of the α particles of ^{148}Gd and its standard deviation were found to be equal to (3182.787 ± 0.024) keV. (FR)

19917 $3^- \rightarrow 4^+$ BETA DECAY IN ^{140}La. Khayyoom, A.; Narasimha Raju, M. L.; Vema Reddy, B.; Sastry, D. L. (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys.; 11: No. 2, 121-123(Feb 1973).

The directional correlation between the once-forbidden non-unique 1710-keV beta particle and the 487-keV gamma ray in the decay of ^{140}La was measured as a function of beta energy in the range 1350 to 1550 keV by employing a fast–slow scintillation assembly. The attenuation of the correlation due to the finite lifetime of the intermediate state was found to be zero within experimental errors, by conducting an integral correlation experiment both in solid and liquid sources. The correlation function obtained varies from 0.19 to 0.23, and shows no appreciable energy dependence within experimental error. The results show that the 1710-keV beta transition in the decay of ^{140}La neither fits into the ξ approximation nor indicates a deviation from the ξ approximation. (3 figures, 1 table) (auth)

19918 GAMMA-RAY ENERGIES OF ^{143,145}Cs AND OF THEIR BETA DECAY PRODUCTS. Wuensch, K. (Univ., Giessen, Ger.); Gunther, H.; Wollnik, H.; Siegert, G. J. Phys., A (London); 6: No. 7, L93-L94(Jul 1973).

Spectroscopic measurements have been performed on neutron-rich fission products from ^{235}U (n_{th},f). The mass separation of thermally ionized short-lived Cs ions in an on-line mass separator is reported. γ ray lines of ^{143,144,145}Cs, ^{143,144,145}Ba and ^{144}La are reported. (auth)

19919 NEW SHORT-LIVED ISOMER IN ^{114}Sb. Gil, C. (Tokyo Univ.); Nishiyama, K.; Nomura, T.; Yamazaki, T.; Miyano, K. J. Phys. Soc. Jap.; 34: No. 4, 874-879(Apr 1973).

A new short-lived isomer in ^{114}Sb was found by using the technique of in-beam gamma spectroscopy. Two new gamma rays at energies of 96 keV and 326 keV, decaying with a half-life of 275 ± 20 μsec, were found. A ratio of the intensity of the 326-keV gamma ray to that of the 96-keV gamma ray was found to be 1.0:0.34. The character of the 326-keV gamma ray was deduced to be E3, enhanced 6.9 times over the single-particle estimate. The 96-keV transition was concluded to be an E2 transition. A decay sequence of 8^- –326 keV (E3) $\rightarrow 5^+$ –96 keV (E2) $\rightarrow 3^+$ (ground state of

^{114}Sb) may be proposed. The observed enhancement of the E3 transition is explained in terms of a mixture of the E3 core polarization. (auth)

19920 QUANTUM-CHEMICAL EVALUATION OF THE CHANGE IN CHARGE RADIUS OF THE ^{125}Te NUCLEUS DURING EXCITATION OF THE 35.45-keV LEVEL FROM GAMMA RESONANCE DATA. Ionov, S. P.; Makarov, E. F.; Baltrunas, D. I. Zh. Strukt. Khim.; 14: No. 1, 65-69(1973). (In Russian).

The value for the ratio $(\Delta R/R)_{Te} = (1.4 \pm 0.2) \times 10^{-4}$ was obtained using the molecular orbital method and data on a series of compounds such as TeF_4, $TeCl_4$, TeO_4^{2-}. The method developed for calculating electron densities in nuclei and molecules was suitable for relative comparisons of chemical shifts in the gamma resonance spectra of compounds of elements of the fifth period: Sn, Sb, Te, I, and Xe. (3 figures, 4 tables) (KSW)

19921 GENERALIZED SENIORITY SCHEME IN N = 50 NUCLEI. Nomura, M. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: No. 3, 1054-1056(Mar 1973).

Shell-model calculations are done for N = 50 nuclei in the framework of the generalized seniority (GS) scheme; an effective interaction and single-particle energies are used. Wave functions for low-lying positive-parity states of ^{92}Mo and ^{94}Ru are tabulated. It is shown that GS is a very good quantum number. (2 tables) (RWR)

19922 AVERAGE CROSS SECTIONS FOR Pu–α–Be NEUTRONS: LOW ENERGY NEUTRONS FROM α–n SOURCES. Peto, G.; Csikai, J.; Shuriet, G. M.; Jozsa, I.; Asztalos, V. (Kossuth Univ., Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 33: No. 3-4, 363-367(1973).

Average activation cross sections for a number of elements were determined using unmoderated neutrons from Pu–Be and Po–Be sources. By applying threshold detectors it was found that 10% of Pu–Be neutrons are emitted in the energy interval 10 to 100 keV. Neutron spectra from Pu–Be_{13} sources of different dimensions were the same within the interval 0.5 to 5 Ci; the majority of neutrons below 2 MeV came from the multibody breakup of ^{13}C. (2 tables) (auth)

19923 Z DEPENDENCE OF PHOTOELECTRIC CROSS SECTIONS. Gowda, R.; Sanjeevaiah, H.; Sanjeevaiah, B. (Univ., Mysore, India). Indian J. Pure Appl. Phys.; 11: No. 2, 124-126 (Feb 1973).

The Z dependence of the photoelectric cross section in copper, silver, tin, gold, and lead at photon energies 280, 323, 412, and 662 keV was studied by using a G–M counting system. A collimated beam of gamma rays from different sources was incident on thin foils of the converter materials. The number of photoelectrons produced in the interaction was estimated by the subtraction method. Correction for self-absorption in the converter was made by the extrapolation technique. The Z dependence of the photoelectric cross section observed compares fairly well with some of the recent theoretically computed and other experimental values. (3 figures, 1 table) (auth)

19924 (n,p) REACTION CROSS SECTION OF ^{116}Cd AT 14.7 MeV. Bjoernstad, T.; Alstad, J. (Univ. of Oslo). Radiochem. Radioanal. Lett.; 14: No. 4, 247-255(30 Jul 1973).

The (n,p) reaction cross section of ^{116}Cd at 14.7 MeV was found to be (2.2 ± 0.5) mb. This value is in fair agreement with the semiempirical prediction by Gardner and Rosenblum of 1.4 mb. (1 figure, 2 tables) (auth)

19925 DECAY OF ^{110}Sb. Miyano, K. (Niigata Univ., Japan) Nakahara, H.; Gil, C. J. Phys. Soc. Jap.; 33: No. 6, 1505-1508 (Dec 1972).

The decay of ^{110}Sb was studied with a Ge(Li) spectrometer and a β counter. The half-life of ^{110}Sb was determined to be 21.3 ± 1.5 sec. The β rays of 6.5, 5.6 and 4.8 MeV were found. Fifteen γ rays were assigned to ^{110}Sb. Twelve new γ rays were observed. The γ-ray energies and intensities observed are 2456 keV (1.7%), 1426 keV (2.9%), 1244 keV (17.1%), 1212 keV (98.3%), 1027 keV (4.2%), 987 keV (44.1%), 910 keV (14.7%), 829 keV (15.1%), 721 keV (15.4%), 643 keV (2.5%), 638 keV (7.7%), 627 keV (2.5%), 523 keV (1.1%), 440 keV (19.1%) and 180 keV (0.4%). The log ft-values were deduced and a tentative decay scheme of ^{110}Sb was proposed. (auth)

19926 HALF-LIFE OF ^{132}Cs. Gindler, J. E.; Flynn, K. F.; Glendenin, L. E. (Argonne National Lab., IL). J. Inorg. Nucl. Chem.; 35: No. 8, 2617-2619(Aug 1973).

132-Cesium was prepared by the ^{133}Cs(γ,n)^{132}Cs reaction. The activity of the 668-keV ^{132}Cs γ-ray was measured at intervals during a period of 55 days. From these measurements, the half-life of the nuclide was determined to be 6.474 ± 0.014 days. (auth)

19927 DECAYS OF ^{114}Sb AND ^{112}Sb. Miyano, K. (Niigata Univ., Japan); Gil, C. J. Phys. Soc. Jap.; 33: No. 6, 1509-1514 (Dec 1972).

Decays of ^{114}Sb and ^{112}Sb were investigated in single and coincidence experiments. In the decay of ^{114}Sb, new γ rays at energies of 322 keV (5.5%), 393 keV (1.1%) and 716 keV (3.8%) were found, in addition to the known γ rays at energies of 887 keV (17.7%) and 1300 keV (100%). The highest β-ray end-point energy was found to be 4.1 MeV. The half-life of ^{114}Sb was determined to be 200 ± 5 sec. In the decay of ^{112}Sb, γ rays at energies of 992 keV (12.1%) and 1258 keV (100%) were seen. The highest β-ray end-point energy was found to be 5.2 MeV. Decay schemes for ^{114}Sb and ^{112}Sb were proposed. Some properties of the decay schemes may be interpreted in terms of the pairing theory. (auth)

19928 LEVEL STRUCTURE OF ^{129}Cs. Ishii, K. (Tokyo Inst. of Tech.); Kageyama, S.; Aoki, T. J. Phys. Soc. Jap.; 34: No. 2, 285-297(Feb 1973).

The level structure of ^{129}Cs was investigated by measuring gamma-rays and internal conversion electrons following the decay of ^{129}Ba with a Ge(Li) detector and a $\sqrt{2\pi}$ air core beta-ray spectrometer. About one hundred fifty gamma-rays were observed. The L-subshell ratios of the 6.5, 53.2, 129.1, 182.3 and 202.4 keV transitions were measured, and the multipolarities and the mixing ratios of these transitions were determined. For the 6.5 keV transition, zero energy loss peaks were observed. The low-lying level energies, spins and parities are as follows: 0($1/2^+$), 6.545($3/2^+$), 135.6($3/2^+$), 188.87($1/2^+$), 208.9($5/2^+$) and 220.8 keV ($3/2^+$) The experimental results of l-forbidden M1 transitions are compared with the theoretical predictions. (auth)

19929 NUCLEAR SPINS OF NEUTRON-DEFICIENT LANTHANUM AND CERIUM ISOTOPES. Ingelman, S.; Ekstroem, C.; Olsmats, M.; Wannberg, B. (Univ. of Uppsala). Phys. Scr.; 7: No. 1-2, 24-30(1973).

Nuclear spins of some neutron-deficient lanthanum and cerium isotopes have been measured by the atomic-beam magnetic resonance method. The results are: ^{131}La (59 min) I = $3/2$, ^{132}La (4.5 h) I = 2, ^{132m}La (25 min) I = 6, ^{133}La (4.0 h) I = $5/2$, ^{135}La (19.4 h) I = $5/2$, ^{136}La (10 min) I = 1, ^{130}Ce (25 min) I = 0, ^{132}Ce (4.2 h) I = 0, ^{133}Ce (5.4 h) I = $9/2$, ^{133m}Ce (97 min) I = $1/2$, ^{134}Ce (72 h) I = 0, ^{135}Ce (17.0 h) I = $1/2$, ^{137}Ce (9.0 h) I = $3/2$, ^{137m}Ce (34.4 h) I = $11/2$, ^{139}Ce (140 d) I = $3/2$. The spin values of nuclei with neutron numbers N ≥ 76 are in accordance with predictions of the spherical shell model. The results obtained on the isotopes further away from the stability line indicate stably deformed nuclear shapes; e.g., for the nuclei ^{131}La, ^{133}Ce and ^{133m}Ce. For the transitional nucleus ^{132}La, no unequivocal interpretation can be made of the ground state and isomeric state spins. (auth)

19930 STUDY OF THE MAGNETIC DIPOLE MOMENTS OF THE ODD-MASS TELLURIUM ISOMERS BY NUCLEAR ORIENTATION. Silverans, R. E.; Coussement, R.; Schoeters, E.; Vanneste, L. (Univ. Louvain, Belg.). Nucl. Phys.; A210: No. 2, 307-316 (1973).

The magnetic moments of ^{123m}Te, ^{127m}Te and ^{129m}Te implanted by isotope separation in an iron lattice have been measured using the low-temperature nuclear orientation technique. The magnitudes of the magnetic dipole moments, extracted from the γ-rays anisotropy measurements, are: $\mu = -1.00(5)$ n.m. for ^{123m}Te, $\mu = -0.91(5)$ n.m. for ^{127m}Te and $\mu = -1.15(5)$ n.m. for ^{129m}Te. The results for these $11/2^-$ isomers are compared to theoretical calculations by the spin polarization procedure using wave functions from the pairing-plus-quadrupole model. (auth)

19931 ^{144}Sm(p,p′) REACTION ON ANALOG RESONANCES. Martin, R. (Univ. of Montreal); Bimbot, L.; Gales, S.; Lessard, L.; Spalding, D.; Weitkamp, W. G.; Dietzsch, O.; Foster, J. L. Jr. Nucl. Phys.; A210: No. 2, 221-244(1973).

The reaction ^{144}Sm(p,p′) has been measured on four analog resonances in the ^{144}Sm + p system at incident proton energies of 9.315, 10.205, 10.910 and 10.980 MeV. In addition to highly excited levels with large neutron particle-hole components, low-lying states in ^{144}Sm also resonate because of neutron coupling to these levels in the parent system. Spectroscopic factors are extracted for states, the spin of which is known or indicated by this experiment. (auth)

19932 NEUTRON CAPTURE CROSS-SECTION OF ^{135}Xe. Santry, D. C.; Werner, R. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Energy; 27: No. 6, 409-413(Jun 1973).

The neutron capture cross-section of ^{135}Xe has been measured by the activity depletion method using mass separated-ion implanted samples and high resolution gamma-ray spectrometry. An effective cross-section value was measured at a neutron temperature of 318 ± 5°K as 3.09 ± 0.07 Mbarns, relative to a ^{59}Co-(n,γ) cross section of 37.09 barns. A calculated value for the ^{135}Xe 2200 m/sec capture cross-section is discussed. (auth)

19933 STUDY OF THE LOW LYING STATES OF ^{148,150,152}Sm AND ^{138}Ba BY INELASTIC ELECTRON SCATTERING. Legg, J. R.

New Haven; Yale Univ. (1972). 113p. University Microfilms Order No. 73-14,572.

Thesis (Ph.D.).

Some of the low lying excited states of ^{138}Ba, ^{148}Sm, ^{150}Sm and ^{152}Sm were investigated by inelastic electron scattering. Angular distribution measurements were performed at 40 and 60 MeV yielding a momentum transfer range for most states of about .3 to .6 F^{-1}. Reduced gamma transition probabilities and transition radii were derived in each case. Generally good agreement was obtained with Coulomb excitation and lifetime measurements. A rotational model was employed to analyze scattering to the first 2^+ state of ^{152}Sm at 122 keV. However, for the range of momentum transfer involved in the present experiment, this rotational model yielded inelastic form factors which did not differ significantly from those predicted by the hydrodynamic model of Tassie. A model describing the excitation of a β-vibrational state was also developed. Comparison with the Tassie model showed that form factors calculated by the β-vibrational model differed by 3 to 10% over the momentum transfer range .3 to .6 F^{-1}. Results are presented for the following excited states: ^{138}Ba: 1.44 MeV (2^+), 2.88 MeV (3^-); ^{148}Sm: .551 MeV (2^+), 1.16 MeV (3^-); ^{150}Sm: .334 MeV (2^+), 1.07 MeV (3^-), 1.19 MeV (2^+); ^{152}Sm: .1218 MeV (2^+). (Diss. Abstr. Int., B)

19934 INELASTIC PROTON SCATTERING FROM ^{138}Ba AND ^{144}Sm AND ITS MICROSCOPIC INTERPRETATION. Larson, D. C. East Lansing, MI; Michigan State Univ. (1972). 151p. University Microfilms Order No. 73-12,758.

Thesis (Ph.D.).

Differential cross sections for elastic and inelastic scattering of 30 MeV protons by ^{138}Ba and ^{144}Sm have been measured. The total resolution for the inelastic peaks was 7-10 keV FWHM, which permitted the observation of 20 excited states in ^{138}Ba and 18 states in ^{144}Sm below Ex = 3.4 MeV, and measurement of excitation energies accurate to 2 keV or less for these states. Based on characteristic shapes derived from angular distributions to states of known J^π, spin-parity assignments were made for the majority of the observed states. Collective model DWBA calculations were performed and deformation parameters extracted for all states of assigned J^π. Microscopic DWBA calculations which included the exchange amplitude were performed for the $2^+_{1,2}$, $4^+_{1,2}$ and $6^+_{1,2}$ states in both nuclei, using large-basis shell model wave functions to describe the nuclear states. These wave functions also provide an excellent description of the excited states in ^{138}Ba, and a good description of the energy levels in ^{144}Sm, as measured in the experiments. The two-body force used in the inelastic scattering calculations was obtained from a recent survey of inelastic scattering analyses. Polarization charges for the nucleons were extracted, and found to be essentially state and multipole independent. Two sets of shell model wave functions were employed for the ^{138}Ba calculation, and it was found that inelastic proton scattering clearly distinguished between the two sets, thus providing a sensitive test of the wave functions. Careful consideration of the transition densities derived from the wave functions enable one to directly study the properties of the wave functions. (Diss. Abstr. Int., B)

19935 NUCLEAR MATRIX ELEMENTS IN THE FIRST-FORBIDDEN BETA DECAY OF ^{84}Rb, ^{122}Sb, ^{124}Sb, AND ^{125}Sb. Schweitzer, J. S. Lafayette, IN; Purdue Univ. (1972). 150p. University Microfilms Order No. 73-15,863.

Thesis (Ph. D.)

Accurate numerical values for the nuclear matrix elements involved in first-forbidden beta decay can be used to apply a significant restriction on nuclear models which attempt to describe the nuclei involved in the transition. However, attempts to extract the nuclear matrix elements of a transition have not been in agreement, even when essentially identical experimental data have been used. Since the results seem to depend on which formalism is used in the analysis, a comparison of the formalisms is made to determine the differences which are due to inconsistencies between the formulas presented in each formalism. The comparison shows that extracted values of nuclear matrix elements should agree to within 10 to 15% unless matrix elements which arise from the radial expansion of the electron radial wave functions make an unusually large contribution to the transition. By using the available experimental data, the nuclear matrix elements were extracted for the first-forbidden beta decay of ^{84}Rb, ^{122}Sb, ^{124}Sb, and ^{125}Sb. In ^{124}Sb it was concluded that the matrix elements arising from the radial expansion of the electron radial wave functions play a significant role. The energy dependence of the beta–gamma circular polarization correlation in ^{84}Rb was measured and used to restrict the matrix elements for this nucleus. (Diss. Abstr. Int., B)

19936 ^{90}Zr(d,d') REACTIONS AT E_d = 15 MeV. Baker, F. T.; Kruse, T. H.; Matthews, J. L.; Williams, M. E. (Rutgers–The State Univ., New Brunswick, NJ). Particles Nucl.; 5: No. 1, 29-41(Jan 1973).

Angular distributions for inelastic deuteron scattering from ^{90}Zr were measured for 15 MeV bombarding energy. The collective model DWBA analysis was performed for 11 levels up to 4.35 MeV excitation energy, and microscopic model DWBA calculations were performed for the lowest 0^+, 2^+, 3^-, 4^+, 5^-, and 6^+ excited states. The microscopic model calculations include the direct, exchange, and imaginary interactions as suggested recently by Satchler. The results indicate that although the magnitudes of the predicted cross sections are in good agreement with the data, neither model accounts well for the shapes of the L = 0, 4, and 6 angular distributions. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 19445, 19879, 19893, 19909, 19933, 19955, and 20002.

19937 (ANU-P-562) ISOBARIC ANALOGUE RESONANCE STUDIES IN SOME RARE-EARTH NUCLEI. Merrill, N. H.; Whineray, S.; Zuk, W. M.; Weisser, D. C.; Hollas, C. L.; Borsaru, M. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 55p. Dep. NTIS (U.S. Sales Only) $4.75.

Isobaric analogue resonances have been investigated by proton scattering on ^{160}Gd, ^{162}Dy, ^{164}Dy, ^{166}Er, ^{168}Er, ^{170}Er and ^{174}Yb. The resonance fits to the (p,p_0) data support orbital angular momentum assignments based on (d,p) studies except in the case of ^{162}Dy(p,p_0). Single particle widths, calculated using the Lane model with an absorptive potential, have been used with the present results to obtain values of C^2_{β} for comparison with (d,p) data and the Nilsson-model values. Coulomb displacement energies have been determined in all cases, and the systematics of these and other data show that a local maximum, within the deformation minimum, exists at A ~ 170. (17 figures, 12 tables) (auth)

19938 LIFETIMES OF 2^+ AND 4^+ STATES IN ^{154}Gd. Awwad, Z.; Badawy, O. E.; El-Aasser, M. R.; El-Rarrash, A. H. (Atomic Energy Establishment, Cairo). Indian J. Pure Appl. Phys.; 10: No. 12, 870-872(Dec 1972).

The half-lives, $T_{\frac{1}{2}}$, of the 123- and 371-keV excited states in ^{154}Gd were reinvestigated and compared with the previously reported values by using an e – e coincidence technique. The transition rates together with some other nuclear parameters were deduced and discussed. The measured lifetimes were found to be $T_{\frac{1}{2}}$ (123 keV) = 1.18 ± 0.04 10^{-9} s and $T_{\frac{1}{2}}$ (371 keV) = 41 ± 7. 10^{-12} s. (2 figures, 2 tables) (auth)

19939 INTERNAL CONVERSION OF THE ELECTRIC DIPOLE TRANSITIONS OF ^{177}Hf. Grigor'ev, V. N.; Kaminker, D. M.; Sergeenkov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 4, 842-847(Apr 1972). (In Russian).

The 71.6-, 208.3-, and 321.3-keV electric dipole transitions of ^{177}Hf resulting from the decay of ^{177}Lu ($T_{\frac{1}{2}}$ = 6.8 days) were studied, and the internal conversion coefficients were determined within an error of 5 to 10%. The values obtained for the 71.6- and 208.3-keV levels did not indicate a contribution of intranuclear conversion. The nuclear parameters and intranuclear matrix elements obtained agreed with predictions of the one-particle model. A prismatic β spectrometer with a resolution of 0.05 to 0.1% was used for the study of the internal conversion spectrum of ^{177}Lu. The absence of anomaly in the internal conversion coefficients at the K shell does not imply the absence of intranuclear conversion which may take place at the L_{II} shell. (TTT)

19940 M_2 TRANSITIONS IN DEFORMED ODD NUCLEI. Erbil, H. H.; Piepenbring, R. (Univ., Grenoble, France). J. Phys. (Paris); 34: No. 4, 275-279(Apr 1973). (In French).

M_2 transitions are calculated using a model which takes into account pairing and coupling correlations between the motion of the particles and collective rotation and vibration modes. The results are systematically compared to experimental results obtained for pure M_2 transitions. (FR)

19941 NUCLEAR MEISSNER EFFECT. Birbrair, B. L.; Nikolaev, K. N. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 4, 855-862(Apr 1972). (In Russian).

The theory of rotational states, originally developed by D. R. Inglis and continued by B. R. Mottelson and J. G. Valatin, was further examined on the assumption that an effect analogous to the Meissner effect exists within the nucleus. The Meissner effect

states that a weak magnetic field does not penetrate within a superconductor, and a strong magnetic field destroys the superconductivity. It is stated that the Meissner effect is due to the rotation of spherical nuclei. The rotational band of the spherical nuclei is created by the gradual alignment of the angular moments of the valence nucleons along the axis of rotation. Similar phenomena arise in the case of the rotation of a deformed nucleus around the axis of symmetry. The study led to the conclusion that from the viewpoint of the microscopic theory of nuclear rotation, the aligned state of spherical nuclei and the K isomers of the deformed nuclei have the same physical character as the so-called "normal" rotational states. This has been confirmed by the direct comparison of the effective moments of inertia of the Meissner levels with the moments of inertia of "normal" rotational bands. Data are presented for ^{178}Hf, ^{176}Yb, and the spherical ^{212}Po nucleus. (TTT)

19942 NUCLEAR ORIENTATION OF ^{175}Yb IN GOLD AND SILVER. Spanjaard, D. (Paris Univ., Orsay, France); Marsh, J. D.; Stone, N. J. J. Phys., F (London); 3: No. 6, 1243-1250 (Jun 1973).

^{175}Yb has been oriented in Au and Ag at very low temperature. From the measured anisotropy of the 283 keV and 396 keV γ rays of Au^{175}Yb, the nuclear dipole moment of ^{175}Yb is deduced. The value found for this moment is much greater than the value quoted previously by Grace et al (Phil. Mag.; 2: 1079-1084(1957)). However it is shown that a reanalysis of their experimental data gives a result very similar to the one reported in the present publication. Also the electric quadrupole moment of this nucleus is deduced. (auth)

19943 PENETRATION EFFECTS IN THE 134 keV TRANSITION IN ^{187}Re. Sahota, H. S.; Sharma, R. K. (Punjab Univ., Patiala, India). Indian J. Phys.; 47: No. 1, 61-63(Jan 1973).

The L subshell ratios and K conversion coefficients are analyzed in conjunction with the theoretical K-shell and L-subshell conversion coefficients for the 134-keV transition in rhenium-187. The values of δ^2 and the penetration factor are deduced. (JFP)

19944 EFFECTS OF THE CORIOLIS MIXING IN ^{181}W. Lindblad, T.; Ryde, H.; Kleinheinz, P. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A210: No. 2, 253-281(1973).

The ^{179}Hf(α,2n)^{181}W and ^{180}Hf(α,3n)^{181}W reactions are used to populate excited states in ^{181}W. Rotational bands built on the $^9/_2^+$[624], $^7/_2^-$[514], $^7/_2^-$[503] and $^5/_2^-$[512] Nilsson states are followed up to levels with spins $^{31}/_2$, $^{21}/_2$, $^{11}/_2$ and $^{11}/_2$, respectively. The observed energy levels and transition probabilities are compared with the predictions of the unified model with pairing and Coriolis interactions included. Agreement between theory and experiment is obtained provided the theoretical Coriolis matrix elements are reduced. The wave functions obtained are also found to reproduce the experimental (d,t) cross section patterns. (auth)

19945 GROUND STATE PROPERTIES OF DEFORMED RARE-EARTH NUCLEI. Ekstroem, C. (Chalmers Tekniska Hoegskola, Goteborg); Lamm, I. L. Phys. Scr.; 7: No. 1-2, 31-48(1973).

Nuclear spins and moments as determined by the atomic-beam magnetic resonance (ABMR) method on isotopes of the heavier rare-earths are compared with results from Nilsson model calculations. Special emphasis is aid on isotopes of the elements dysprosium, holmium, erbium and thulium on which in recent years the experimental body has increased considerably. From systematic trends, nuclear spins and moments are also theoretically predicted in several cases where experimental data are lacking. (auth)

19946 NUCLEAR ORIENTATION MEASUREMENTS ON ^{183}Re AND ^{184}Re. Huebel, H. (Univ., Bonn); Guenther, C.; Schoeters, E.; Silverans, R. E.; Vanneste, L. Nucl. Phys.; A210: No. 2, 317-328(1973).

^{183}Re and ^{184g,184m}Re nuclei embedded in an iron matrix were oriented at low temperatures. From the temperature dependence of the 0-90° anisotropies of several γ-rays the magnetic hyperfine interaction in the ^{183,184}Re ground states and the ^{184m}Re isomeric state as well as mixing ratios of transitions in the ^{183,184}W daughter nuclei were determined. The results for the magnetic moments [$\mu(^{183}\text{Re}) = 3.03 \pm 0.11$ n.m., $\mu(^{184}\text{Re}) = 2.53 \pm 0.09$ n.m., $\mu(^{184m}\text{Re}) = 2.86 \pm 0.13$ n.m.] and the mixing ratios are discussed within the framework of the rotational model. (auth)

19947 SEMI-EMPIRICAL EXPRESSIONS FOR PHOTON AND PHOTO-NEUTRON PRODUCTION FROM TARGETS BOMBARDED WITH ELECTRONS. Narita, M.; Ozawa, Y. (Hokkaido Univ., Sapporo). Hokkaido Daigaku Kogakubu Kenkyu Hokoku; No. 66, 63-73(Mar 1973). (In Japanese).

The photon production efficiency of a thick target (for bremsstrahlung) as a function of incident energy, E_0, and atomic number, Z is found to be $C = 1 - (800/E_0Z) \ln [(1 + ZE_0/800)]$. By using an approximated photon spectrum, a semiempirical expression for neutron yield per unit length from targets bombarded with electrons can be expressed as $Y(E_0,Z) = n\sigma_T (E_0Z/E_0Z + 800) \ln [(E_0/E_T) - (E_0 - E_T/E_0)]$ where n is the atomic density, σ_T is the giant resonance integral, and E_t is the threshold energy of (γ,n) reaction. The present estimated yields agree fairly well with experimental values at several tens of MeV for both E_0 and Z dependence. (auth)

19948 NUCLEAR DATA SHEETS FOR A = 159. Tuli, J. K. (Indiana Univ., Bloomington). Nucl. Data, Sect. B; 9: No. 5, 435-477(May 1973).

Nuclear data based upon reaction and radioactivity studies of mass-159 nuclei are presented. For A = 159 all nuclei with $63 \leq Z \leq 72$ with the exception of Yb and Lu have been reported; but not much is known for Eu, Er, Tm, and Hf isobars other than their ground-state properties. The only stable nucleus with A = 159 is ^{159}Tb, and it has been studied in considerable detail, both by nuclear reactions and radioactive decay of its neighboring isobars. Because of ambiguity in beta branching in ^{159}Eu decay (and since the beta branch to ^{159}Tb g.s. in ^{159}Gd decay is known only approximately), the normalizations in these radioactive decays are rather uncertain. For brevity some of the older data have been omitted or referenced as other measurements. It has been attempted to include all available data prior to February 1, 1973. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 19819, 19829, 19830, 19837, 19876, 19879, 19880, 19893, 19909, 19922, 19923, 19941, 19957, 19976, and 20002.

19949 (NP-19813) ^{207}Pb(d,p)^{208}Pb REACTION WITH HIGH RESOLUTION. Void, P. B.; Andreassen, J. O.; Lien, J. R.; Graue, A.; Cosman, E. R.; Duennweber, W.; Schmitt, D.; Nuesslin, F. (Bergen Univ. (Norway). Dept. of Physics). 1973. 31p. Dep. NTIS (U. S. Sales Only) $3.75.

The reaction ^{207}Pb(d,p)^{208}Pb has been studied at $E_d = 18.0$ MeV using the MPI Heidelberg Emperor tandem accelerator and multiple-gap spectrograph. The average resolution of 18 keV was better than previous measurements, and this, combined with the long beam exposure, allowed many finer details of the neutron particle-hole structure of ^{208}Pb to be examined. In all, 45 levels were seen up to $E_x = 6.3$ MeV, many of which had never been seen before. A DWBA analysis of the stripping transitions angular distributions was made, and values of $(2J + 1)S_{lj}$, energy centroids, and summed strengths are given. An interesting cluster of $1i_{13/2}$ and $2g_{9/2}$ levels at $E_x \simeq 4.2$ MeV were resolved and are compared to recent isobaric analog-state data. A search for weak stripping strength to known pairing vibrations in ^{208}Pb gave essentially negative results and points to the need for improved ultra-resolution measurements. (auth)

19950 ISOMERIC CROSS SECTIONS FOR (n,2n) REACTIONS IN THALLIUM, LEAD, AND BISMUTH AT 14.9 MeV. Salaita, G. N.; Eapen, P. K. (Southern Methodist Univ., Dallas). J. Inorg. Nucl. Chem.; 35: No. 7, 2139-2143(Jul 1973).

The cross sections for the ^{205}Tl(n,2n) ^{204m}Tl, ^{203}Tl(n,2n) ^{202m,g}Tl, ^{206}Pb(n,2n) ^{205m}Pb, ^{207}Pb(n,2n) ^{206m}Pb, ^{208}Pb(n,2n) ^{207m}Pb and ^{209}Bi(n,2n) ^{208m}Bi reactions have been measured using the cyclic activation technique and a high-energy resolution Ge(Li) detector. The experimentally determined values of formation cross sections are 664 ± 60, 670 ± 60 and 2482 ± 220, 866 ± 77, 1017 ± 92, 1310 ± 116 and 393 ± 35 mb, respectively. The half-lives of the induced isomeric activities have been determined using a wide range time-to-pulse height converter and a multichannel analyzer. (auth)

19951 STUDY OF THE γ-RAY SPECTRA EMITTED IN Au RESONANCES AFTER NEUTRON CAPTURE. Lottin, A.; Jain, A. (CEN, Gif-sur-Yvette, France). J. Phys. (Paris); 34: No. 2, 123-129(Feb 1973). (In French).

The γ-ray spectra resulting from neutron capture resonances in ^{197}Au were studied for energies up to 400 eV. The high-energy lines were analyzed and the scheme for the first excited states of ^{198}Au was constructed. The spins and parities were determined for a large number of excited states by using known resonance spins and transition multipolarities. Spins are assigned to the remaining resonances. No correlation was found between the intensity of the lines and the reduced neutron width of the resonances. (FR)

19952 EFFECTIVE CHARGE OF THE $h_{9/2}$ PROTON IN ^{210}Po. Berg, V.; Bourgeois, C.; Perrin, N. (Paris Univ., Orsay, France).

Compt. Rend., Ser. A, B; 276: No. 18, 761-764(2 May 1973). (In French).

In order to evaluate the effective charge of the $h_{\frac{9}{2}}$ proton in ^{210}Po, the mean lives of the 4+ and 6+ levels at 14.26.7 and 1473.2 keV respectively were measured. The results obtained, $T_{(\frac{1}{2})(4+)}$ = (1.53 ± 0.08)ns and $T_{(\frac{1}{2})(6+)}$ = (43.0 ± 1.5)ns, yield values for the effective charge of (1.72 ± 0.05)e and (1.67 ± 0.04)e respectively. The values obtained are 10% higher than those evaluated for the $h_{\frac{9}{2}}$ proton value evaluated in ^{209}Bi. (auth)

19953 ANALYSIS OF ^{197}Au(n,p) SPECTRUM AT 14 MeV. Manocha, K. K.; Nohindra, R. K. (Kurukshetra Univ., India). Indian J. Pure Appl. Phys.; 11: No. 1, 61-63(Jan 1973).

The spectra of protons emitted from ^{197}Au upon bombardment with 14-MeV neutrons were computed on the basis of the evaporation model, the oscillations of the excited nucleus were taken into account. Various level density formulas were used. Both the optical model and square well potential cross sections were used, and the results were compared. The qualitative agreement of the calculated energy distribution with the experimental energy distribution of protons is found to be good, and explains fairly well the presence of the peaks in the experimental spectra of heavy elements. (4 figures) (auth)

19954 NUCLEAR DATA SHEETS FOR A = 191. Lewis, M. B. (Oak Ridge National Lab., TN). Nucl. Data. Sect. B; 9: No. 5, 479-513(May 1973).

Level schemes, spin and parity assignments, and decay properties are presented for all nuclei with mass number A = 191. Experimental data and adopted values are given along with conclusions as to the spin and parity assignments. The presentation of the nuclear properties is given in the light of the data and current theoretical ideas. In this transition region, level decay rates are seen to be of particular importance, and so have been summarized in terms of multipole enhancement or hindrance. The compilers have attempted to bring out some inconsistencies in the data and resolve discrepancies when possible. Deficiencies in the data include reaction data leading to ^{191}Pt, rigorous spin assignments for ^{191}Pt, and determination of the ground-state properties of ^{191}Hg. An abundance of data on stable ^{191}Ir shows that nuclear deformations are already a prominent characteristic in this transitional nucleus. Level schemes for each of the A = 191 nuclei are presented first. Then for each nucleus is presented a summary of level properties, gamma or transition rate properties, and comments. Finally, the data and references are given for each nucleus. Energy units are keV unless otherwise noted. Adopted level and decay properties are based on data received before February 1973. (auth)

19955 TOTAL GAMMA-RAY CROSS SECTIONS. Ramana Murty, M. V.; Parthasaradhi, K.; Ramamurty, S. (Andhra Univ., Waltair, India). Nucl. Sci. Eng.; 51: No. 3, 337-339(Jul 1973).

The experimental total gamma-ray cross sections in the region 30 keV to 17.6 MeV are compared with the recent theoretical values and found to be in satisfactory agreement within 5% in general. (2 figures) (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 18279–18281, 19811, 19893, 19903, 19909, 19940, 19955, and 20002.

19956 (AECL-3037(Pt. 2)) FISSION PRODUCT DATA FOR THERMAL REACTORS. Part II. Yields. Walker, W. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1973. 68p. Dep. NTIS (U.S. Sales Only) $5.00. AECL $1.50.

Thermal neutron cumulative fission yields from ^{235}U, ^{233}U, ^{239}Pu, and ^{241}Pu are reviewed. Particular attention is given to mass spectrometric data, which account for the greater fraction of the total yields. A three-step treatment of spectrometric data is used: first, the concentrations of isotopes of each fission product element are determined to define the local shape of the yield vs mass curve; second, the relative numbers of atoms of each element formed in fission are derived from isotope dilution or isobaric coupling measurements, thus linking together all the isotopic concentrations of both the light- or heavy-mass peaks to obtain the shape over the entire mass spectrometric range; third, the mass spectrometric data are normalized using isotope dilution measurements of the number of fissions and radiometric and interpolated yields. In general, the greatest source of uncertainty in the mass spectrometric range is the second step, and appears to arise from systematic differences between the methods used in different laboratories. (2 figures, 30 tables) (auth)

19957 (CONF-700705–(Vol.2), pp 503-509) SEARCH FOR SPONTANEOUSLY FISSIONING ISOMERS WITH NANOSECOND HALF-LIVES PRODUCED BY 600 MeV PROTONS. Montgomery, D.; Brandt, R. (Institut fuer Kernchemie, Marburg, Ger.). 1970.

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

The recoil technique was used in which reaction products recoil out of the target as a result of the momentum transferred by the beam. Mica detectors were placed so that they could record fission fragments from nuclei fissioning after recoil. The first setup consisted of a closed plexiglas chamber with removable cover. The irreproducible results obtained suggested that target material was transferred to the downstream window. Verification of this revealed that a closed chamber was not suitable. A vacuum chamber open at both ends was then used. Although the background was an order of magnitude lower than that for the closed chamber, the data were not, within experimental uncertainty, above background. It thus appears that the cross section for spontaneously fissioning isomers produced by 600-MeV protons on UF_4, ThF_4, and Bi targets is below the limit of the detection system. An upper limit for production was given as 10^{-30} cm^2. It is also possible that the isomers produced are so short-lived that they decay before detection. (2 figures, 2 tables) (RWR)

19958 (CONF-700705–(Vol.2), pp 511-520) TERNARY FISSION INDUCED BY Ar AND Ca IONS IN $ThSiO_4$ CRYSTALS. Boos, A. H.; Brandt, R. (Univ., Marburg, Ger.). 1970.

From seventh international conference on corpuscular photography and visual solid detectors; Barcelona, Spain (7 Jul 1970).

Synthetic $ThSiO_4$ crystals were irradiated with 265-MeV Ar, 305-MeV Ar, and 305-MeV Ca ions. The crystals served as a target as well as a solid state track detector with a 4π geometry. After etching with H_3PO_4 fission tracks produced by the ions in Th could be observed with an optical microscope. In all cases, tracks from binary and ternary fission were found. In the 265-MeV Ar experiment long tracks were observed, probably from the interaction of Ar with the Al degrader. 305-MeV Ar ions produced only a few long tracks, whereas 305-MeV Ca ions gave many short tracks. These tracks from the incoming particles were all parallel, and could therefore be distinguished from fission tracks. For the system 305-MeV Ar + Th the ratio of ternary to binary fission was (0.7 ± 0.4)%. For ternary fission events the angles between the fission tracks and the direction of the ion beam showed a forward and backward peaking. (6 figures, 2 tables) (auth)

19959 (COO–3496-29) STUDIES OF NUCLEAR FISSION, LOW ENERGY NUCLEAR REACTIONS AND TRANSURANIC NUCLEI. Progress Report, June 1, 1972–June 1, 1973. Huizenga, J. R. (Rochester Univ., N. Y. Dept. of Chemistry). 1973. Contract AT(11-1)-3496. 109p. Dep. NTIS $7.50.

Research at the University of Rochester is reported in the following subject areas: heavy-ion reactions and fission; statistical nuclear decay, including both experiment and theory; direct reaction studies on heavy deformed targets, including inelastic scattering and transfer reactions (such as the (d,t), (^{3}He,α), (^{3}He,d), (α,t), and (p,t) reactions); and nuclear methods in chemical structure. A list of publications and invited lectures is also given. (RWR)

For title listings of selected papers see: 19851, 19865, 19901, and 19960–19966.

19960 (COO–3496-29, pp 2-8) ELASTIC SCATTERING OF LITHIUM ON ^{232}Th AND ^{238}U. Freiesleben, H.; Rizzo, G. T.; Huizenga, J. R.; Prince, A. 1973.

In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19961 (COO–3496-29, pp 9-13) FRAGMENT CORRELATION ANGLE MEASUREMENTS OF ^{6}Li AND ^{7}Li INDUCED FISSION OF ^{232}Th AND ^{238}U. Freiesleben, H.; Huizenga, J. R. 1973.

In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19962 (COO-3496-29, pp 14-19) ANGULAR DISTRIBUTIONS FOR ^{6}Li AND ^{7}Li INDUCED FISSION OF ^{232}Th AND ^{238}U. Freiesleben, H.; Rizzo, G. T.; Huizenga, J. R. 1973.

In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19963 (COO-3496-29, pp 20-27) TOTAL REACTION CROSS SECTION OF ^{6}Li AND ^{7}Li ON ^{232}Th AND ^{238}U. Freiesleben, H.; Rizzo, G. T.; Huizenga, J. R.; Prince, A. 1973.

In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19964 (COO-3496-29, pp 32-35) THRESHOLD PHOTOFISSION: THEORY AND EXPERIMENT. Huizenga, J. R.; Britt, H. C. 1973.

In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19965 (COO-3496-29, pp 64-74) COLLECTIVE STATES EXCITED IN THE ^{234}U(d,d') AND ^{236}U(d,d') REACTIONS. Boyno, J. S.; Elze, T. W.; Huizenga, J. R.; Bemis, C. E. Jr. 1973.
In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19966 (COO-3496-29, pp 75-80) SINGLE PROTON STATES IN ^{249}Bk. Boyno, J. S.; Freiesleben, H.; Huizenga, J. R.; Kalbach-Cline, C.; Bemis, C. E.; Hoff, R. W. 1973.
In studies of nuclear fission, low energy nuclear reactions and transuranic nuclei.

19967 (EANDC(E)-157-U(Vol.1)) PROGRESS REPORT ON NUCLEAR DATA RESEARCH IN THE EUROPEAN COMMUNITY FOR THE PERIOD JANUARY 1 TO DECEMBER 31, 1972. (European American Nuclear Data Committee). Mar 1973. 128p. Dep. NTIS (U. S. Sales Only) $8.50.
Research done at the following institutions is reported: Institut fuer Angewandte Kernphysik, Kerforschungszentrum, Karlsruhe, Germany; Institut fuer Neutronenphysik und Reaktortechnik, Kernforschungszentrum, Karlsruhe, Germany; Institut fuer Reine und Angewandte Kernphysik, Universitaet Kiel (IKK), Geesthacht, Germany; Institut fuer Experimentalphysik, Universitaet Hamburg, Germany; Physik-Department der Technischen Universitaet, Muenchen, Germany; Central Bureau for Nuclear Measurements, Euratom, Geel, Belgium; and Reactor Centrum Nederland, Petten, The Netherlands. The items are rather short, about a page in length, and only some of them contain actual data. Although the emphasis is on neutron reactions, other subjects, such as chemical preparations and analysis, are also included. (RWR)

For title listings of selected papers see: 19825, 19866, 19968-19974, and 20028.

19968 (EANDC(E)-157-U(Vol.1), pp 1;3-4;6) NEUTRON FISSION CROSS SECTION OF ^{235}U BETWEEN 0.5 AND 1.2 MeV. Kaeppeler, F. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1973.

19969 (EANDC(E)-157-U(Vol.1), pp 7-8;10;12) FAST FISSION CROSS SECTION OF ^{235}U, ^{238}U, AND ^{240}Pu. Cierjacks, S.; Brotz, P.; Groeschel, D.; Schouky, I.; Newstead, C. M.; Schmalz, G.; Toepke, R.; Voss, F. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1973.

19970 (EANDC(E)-157-U(Vol.1), pp 14-15;18;20) MEASUREMENT OF GAMMA-RAY SPECTRA FROM THERMAL NEUTRON INTERACTION WITH ^{235}U. Matussek, P.; Ottmar, H.; Piper, I.; Weitkamp, C.; Woda, H. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1973.

19971 (EANDC(E)-157-U(Vol.1), pp 15-16;19;21-23) STUDY OF ^{240}Pu BY THERMAL AND AVERAGE RESONANCE CAPTURE OF NEUTRONS IN ^{239}Pu. Ottmar, H.; Matussek, P.; Weitkamp, C.; Woda, H. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1973.

19972 (EANDE(E)-157-U(Vol.1), pp 17; 19;24) OCTUPOLE BANDS IN ^{243}Pu FROM THERMAL NEUTRON CAPTURE IN ^{241}Pu. Matussek, P.; Ottmar, H.; Weitkamp, C.; Woda, H. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1973.

19973 (EANDC(E)-157-U(Vol.1), pp 25;29-31) PROMPT FISSION NEUTRON SPECTRA OF ^{235}U, ^{239}Pu, AND ^{252}Cr. Werle, H.; Bluhm, H. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1973.

19974 (EANDC(E)-157-U(Vol.1), pp 64-66) EMPIRICAL FORMULA FOR RADIATIVE WIDTHS OF NEUTRON RESONANCES. Rohr, G.; Weigmann, H. (Central Bureau for Nuclear Measurements, Geel, Belg.). Mar 1973.

19975 (IAE-2168) INFLUENCE OF DOPPLER EFFECT ON THE SHAPE OF THE NEUTRON RESONANCE. Buryukov, S. A.; Zenkevich, V. S.; Kurilo, V. S.; Moskalev, S. S. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 12p. (In Russian). INIS.
The total cross section of a sample of ^{239}Pu with an admixture of ^{240}Pu was measured with a time-of-flight neutron spectrometer at room and nitrogen temperatures by using the IAE electron accelerator as a neutron source. An analysis of the experimental curves showed that chilling the sample with liquid nitrogen increased the observed cross section by some 12% for ^{239}Pu resonances in the 7 to 20 eV region. The resonance position remained unchanged up to the accuracy of the channel width. The halfwidth of the ^{240}Pu resonance at 1.056 eV was reduced by cooling by 23% (for T = 293°K Γ_{exp} = 56.5 meV, for T = 100°K Γ_{exp} = 43.3 meV). A resonance shift was not observed. The experimental data did not confirm the assumption of strong coupling. Fitting the curves calculated (on the basis of weak coupling and a gaseous model) to the experimental data did not lead to total agreement with experiment as a result of the existing systematic distortion of the shape of the resonance line. (tr-auth)

19976 (LA-UR-73-625, pp 8-10) MATERIALS IDENTIFICATION AND ANALYSIS WITH STOPPED MUONS. Malanify; Umbarger; Augustson; East; Close. 1972.
From U.S. Nuclear Data Committee meeting; Oak Ridge, TN (9 May 1973).
In Reports to the U.S. Nuclear Data Committee.

19977 (LA-UR-73-960) DETERMINATION OF SPINS OF INTERMEDIATE STRUCTURE RESONANCES IN SUBTHRESHOLD FISSION. Keyworth, G. A.; Lemley, J. R.; Olsen, C. E.; Seibel, F. T.; Dabbs, J. W. T.; Hill, N. W. (Los Alamos Scientific Lab., N. Mex.; Oak Ridge National Lab., Tenn.). 1973. 17p. (CONF-730823-5; SM-174/65). Dep. NTIS $3.00.
From 3rd symposium on physics and chemistry of fission; Rochester, New York, USA (13 Aug 1973).
The appearance of prominent intermediate structure in subthreshold fission is currently ascribed to coupling between the normal (Class I) compound-nucleus states and Class II states belonging to the second minimum in a double-humped fission barrier. This explanation requires that only Class I resonances of a single spin state be enhanced through coupling to a Class II state of the same spin. In order to verify this explanation, the fission (σ_f) and total (σ_T) cross sections of ^{237}Np for resonance energy neutrons were measured with a polarized neutron beam and polarized target by using time-of-flight methods. Neutrons from the Oak Ridge Electron Linear Accelerator were polarized by transmission through a dynamically pumped proton sample. The ^{237}Np was polarized in a ferromagnetic medium cooled by a ^{3}He-^{4}He dilution refrigerator. The individual fine-structure resonances comprising the Class II structure at 40 eV incident neutron energy were determined to have the same spin, $J^{\pi} = 3^{+}$. Spins of 14 other Class II structures below 1 keV were also determined, although the fine structure is unresolved. Comparison of these results with earlier data on the angular distribution of fission fragments from aligned ^{237}Np reveals an apparent admixing of transition states, as evidenced by nonintegral values of the projection quantum number, K. (2 figures, 6 tables) (auth)

19978 (LA-UR-73-968) PROMPT AND DELAYED NEUTRON YIELDS FROM LOW ENERGY PHOTOFISSION OF ^{232}Th, ^{235}U, ^{238}U, AND ^{239}Pu. Caldwell, J. T.; Dowdy, E. J.; Worth, G. M. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 20p. (CONF-730823-2; SM-174/100). Dep. NTIS $3.00.
From 3rd symposium on physics and chemistry of fission; Rochester, New York, USA (13 Aug 1973).
The simultaneous measurement, using a single detector, of the mean number of prompt neutrons per fission, the absolute delayed neutron fractions, and the mean ratio of the neutron emission width to the fission width are reported for photoexcitation of ^{232}Th, ^{235}U, ^{238}U, and ^{239}Pu using electron bremsstrahlung from 8-, 10-, 10.2-, and 12-MeV electrons. The neutron detector was a polythene cube, edge 61 cm, containing fifty-three ^{3}He proportional counter tubes. (4 figures, 4 tables) (RWR)

19979 (LA-UR-73-1010) PROMPT NEUTRONS FROM THE SPONTANEOUS FISSION OF FERMIUM-257. Balagna, J. P.; Farrell, J. A.; Ford, G. P.; Hemmendinger, A.; Hoffman, D. C.; Veeser, L. R.; Wilhelmy, J. B. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 17p. (CONF-730823-1; SM-174/77). Dep. NTIS $3.00.
From 3rd symposium on physics and chemistry of fission; Rochester, New York, USA (13 Aug 1973).
Prompt neutrons emitted following the spontaneous fission of ^{257}Fm were measured by using a 75-cm-dia Gd loaded liquid scintillator (neutron detection efficiency = 66.5%). A chamber containing ^{257}Fm and ^{252}Cf sources, each facing a Si surface-barrier detector, was placed in the center of the tank. The average number of neutrons emitted for ^{257}Fm spontaneous fission was found to be 3.77 ± 0.02, based on a value of $\bar{\nu}$ = 3.735 ± 0.014 for ^{252}Cf. The variance of the neutron multiplicity distribution is 2.49 ± 0.06 for ^{257}Fm, compared with 1.56 ± 0.02 for ^{252}Cf. The variation of $\bar{\nu}$ as a function of single fragment kinetic energy was investigated. For ^{257}Fm, $\bar{\nu}$ is ≈1 for the highest 1% of the single-fragment kinetic energies, while for ^{252}Cf the value is 3. The high-kinetic-energy fragments from the fission of ^{257}Fm are principally from symmetric mass splits, while in ^{252}Cf they are from asymmetric divisions. Low neutron emission from symmetric division in ^{257}Fm is consistent with the prediction of spherically stabilized fragments near the scission point due to the proximity of the ^{132}Sn doubly magic core. (7 figures, 2 tables) (auth)

19980 (LIB/Trans-483) CORRELATION BETWEEN THE EXCITATION ENERGIES OF TWO COMPLEMENTARY FRAGMENTS IN THE SPONTANEOUS FISSION OF ^{252}Cf. Signarbieux, C.; Poitou, J.; Ribrag, M.; Matuszek, J. Translated from Phys. Lett., B; 39: No. 4, 503-506(1972). 8p. Dep. NTIS (U. S. Sales Only) $3.00.

An abstract of this article prepared from the original has appeared as NSA, 26: 37516 (1972). (AT)

19981 (ORNL-4804) ^{238}U NEUTRON ELASTIC-SCATTERING CROSS SECTIONS FROM 6.44 TO 8.56 MeV. Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Jun 1973. Contract W-7405-eng-26. 17p. Dep. NTIS $4.00.

Measured ^{238}U neutron differential cross sections for elastic scattering (+ inelastic scattering to levels ≤0.309 MeV) at incident neutron energies of 6.44, 7.54, and 8.56 MeV are presented. The data are in agreement with previous results. ENDF/B MAT 1158 elastic angular distributions are in excellent agreement with experimental results from 6.4 to 8.56 MeV. The ENDF/B 1158 angle-integrated elastic cross section represents a reasonable fit to experimental results from 4 to 8.5 MeV. (3 figures, 3 tables) (auth)

19982 (ORNL-tr-2694) ENERGY DEPENDENCE OF THE RATIO Γ_n/Γ_f IN THE REGION OF TRANSURANIUM ELEMENTS. Barashenkov, V. S.; Zheregi, F. G.; Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. Translated from JINR-P7-6619. 4p. Dep. NTIS $3.00.

It is shown that, contrary to widespread opinion, the ratio of fission-evaporation widths, Γ_n/Γ_f, for transuranium elements may depend essentially on the excitation energy. As a rule, some other value rather than ratio Γ_n/Γ_f is measured experimentally. This value turns out to be practically independent of the energy, both in theory and in experiment. (1 figure, 1 table) (auth)

19983 LEVELS OF ^{234}U EXCITED IN THE DECAY OF ^{234m}Pa. Marsol, C.; Ardisson, G. (Institut d'Etudes Nucleaires, Algiers). Compt. Rend., Ser. A, B; 276: No. 11, 437-440(12 Mar 1973). (In French).

The γ spectrum of UX_2 was measured with a Ge(Li) detector and by the coincidence method. Thirty-six new lines are presented. A level scheme for ^{234}U is proposed in which the 1458.1, 1667.7, 1796.2, 1863.8 and 1970.0 keV excited states appear. (FR)

19984 MEASUREMENT OF THE VARIATION IN THE MEAN NUMBER OF PROMPT NEUTRONS EMITTED IN THE FISSION OF ^{239}Pu INDUCED BY RESONANCE NEUTRONS. Trochon, J.; Lucas, B.; Michaudon, A.; Paya, D.; Ryabov, Yu. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris); 34: No. 2, 131-137 (Feb 1973). (In French).

The mean number of neutrons emitted in the fission of ^{239}Pu induced by resonance neutrons was measured at Saclay using the 60-MeV Saclay electron linac as a pulsed neutron source. The apparatus used included four recoil proton liquid scintillators. The results obtained are presented and compared with those obtained in other laboratories. No correlation was observed between the mean number of neutrons emitted and the spin J^π of the resonance; the fluctuations in the value of this number between the different resonances are, if they exist, less than 2%. (FR)

19985 NUCLEAR LEVELS OF ^{228}Th POPULATED IN THE DECAY OF ^{228}Pa. Kurcewicz, W. (Inst. of Nuclear Research, Warsaw); Strycznlewicz, K.; Zylicz, J.; Broda, R.; Chojnacki, S.; Walus, W.; Yutlandov, I. J. Phys. (Paris); 34: No. 2, 159-174 (Feb 1973).

Various techniques were used to study the decay of ^{228}Pa to ^{228}Th levels. Single γ and K x-ray spectra were measured using Si(Li) and Ge(Li) detectors. A set of two Ge(Li) detectors was used to study $\gamma-\gamma$ and $\gamma-$K x-ray coincidences. A Ge(Li) detector and a six-gap magnetic β-spectrometer were used to measure the γ spectra in coincidence with selected internal conversion lines. Finally, spectra of internal conversion electrons were studied using a β-spectrometer and a Si(Li) detector in conjunction with a system of diaphragms in a homogeneous magnetic field. The decay scheme was constructed and includes 39 ^{228}Th levels. It accounts for 111 of the 160 transitions assigned to the ^{228}Pa activity. The electron-capture decay energy was determined to be $2103^{+\frac{4}{3}}$ keV. The strength distribution for the electron-capture feeding of the ^{228}Th levels is analyzed in terms of nuclear models. The Coriolis mixing of four octopole bands (K = 0, 1, 2 and 3) is studied in detail. The coupling matrix elements deduced from the experiment are compared with the results of microscopic-model calculations. (FR)

19986 SPIN-DEPENDENT STATISTICS OF PARTIAL WIDTHS OF RESONANCE LEVELS. Furman, M.; Yaneva, N. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 23: 121-125(1973). (In Bulgarian).

A method for analysis of the partial widths of resonance levels of fissile nuclei which takes account of the spin of the compound nucleus is presented. For analysis of the experimental sets of fission widths by means of comparison with a four-parameter distribution, a FORTRAN program was written. The distribution parameters are obtained by the least-squares method. Analysis of the experimental sets of 78 fission widths of ^{235}U and 32 fission widths of ^{239}Pu was carried out. The mean fission widths and degrees of freedom obtained for each spin state of the compound nucleus are presented in a table. The results are in agreement with previous work. (2 figures, 1 table) (auth)

19987 PROMPT $\bar{\nu}$ VALUES OF ^{235}U AND ^{239}Pu IN SOME FAST REACTOR SPECTRA. Widen, L.; Conde, H. (Foersvarets Forskningsanstalt, Stockholm). J. Nucl. Energy; 27: No. 6, 395-407(Jun 1973).

The averaged number of prompt neutrons per ^{235}U and ^{239}Pu fission has been measured in fast and thermalized neutron fluxes at the fast zero-power reactor (FRO) at Studsvik, Sweden. The measurements were made with three different reactor cores giving median fission energies for ^{235}U (core centre) of 50, 170, and 240 keV. The spectrum-averaged $\bar{\nu}$ data were compared with the corresponding thermal $\bar{\nu}$ data. The $\bar{\nu}$-value of the spontaneous fission of ^{252}Cf was used as an intermediate standard. The fission samples were placed in neutron beams extracted from the reactor cores, and a large liquid scintillator was used as the fission neutron detector. The experiment also included relative fission rate measurements, ^{238}U/^{235}U, for the three reactor cores. The results are compared with calculated relative $\bar{\nu}$-values deduced from different sets of recently evaluated fission cross section and $\bar{\nu}$-data and from different assumptions concerning the reactor neutron spectra. Within the experimental one-standard-deviation errors of 1.5 and 2% for ^{235}U and ^{239}Pu a good agreement was obtained between the experimental and calculated data assuming $\bar{\nu}$-values in the fission resonance region equal to ν at thermal energy. (auth)

19988 FRAGMENT YIELDS FROM SPONTANEOUS FISSION OF ^{252}Cf. Skovorodkin, N. V.; Lozhkomoev, G. E.; Petrzhak, K. A.; Sorokina, A. V.; Aleksandrov, B. M.; Krivokhatskii, A. S. At. Energ. (USSR); 34: No. 5, 365-371(May 1973). (In Russian).

The absolute cumulative mass yields of 39 nuclides from the spontaneous fission of ^{252}Cf were determined by radiochemical means. The fission rate of the sample was determined by comparing its neutron rate with that of a standard. A correlation was established between the observed fine structure in primary fragment yields. The results are compared with published values. (3 figures, 5 tables, 28 references) (auth)

19989 INFLUENCE OF THE EXCITATION ENERGY OF THE COMPOUND NUCLEUS ^{240}Pu ON THE FISSION CHARACTERISTICS. Penning, G. Ghent; Ghent Rijksuniversiteit (1972). 128p. (In Dutch).

Thesis.

The effect of ^{240}Pu excitation energy on the properties of fission fragments, the mass number of emitted neutrons, and kinetic energy is studied. During thermal fission the average kinetic energy of the fission fragments is greater by 1.1 MeV than that during spontaneous fission. The relation between the kinetic energy and the fragment mass is studied. It is found that the symmetric fission is the most probable when the kinetic energy is the smallest. Fine structure appears in the mass distributions. This effect is greater for spontaneous fission. (JFP)

19990 CHARGE DISTRIBUTION OF HALOGEN NEUTRON EMITTERS FROM NEUTRON-INDUCED FISSION OF THORIUM, URANIUM, AND PLUTONIUM ISOTOPES. Grimm, W. Mainz Univ. (1973). 270p. (In German).

Thesis.

The cumulative fission yields of the nuclides ^{87}Br, ^{88}Br, ^{89}Br, ^{90}Br and ^{137}I, ^{138}I and ^{139}I in the reactions ^{233}U(n_{th},f) and ^{239}Pu(n_{th},f) have been determined, as well as the yields of ^{91}Se in the reactions ^{235}U(n_{th},f) ^{233}U(n_{th},f) and ^{239}Pu(n_{th},f). The fission yield of ^{137}Te has been determined in the reactions ^{235}U(n_{th},f) and ^{239}Pu(n_{th},f), and the reactions ^{238}U(n_{14},f), ^{235}U(n_f,f) and ^{232}Th(n_{14},f) and ^{232}Th(n_f,f) have been examined to verify the yields of the nuclides ^{87}Br, ^{88}Br, and ^{137}I. The results have been obtained by neutron counting as a measurement relative to the corresponding reference reaction ^{235}U(n_{th},f). A schematism for classifying the various fission yields is proposed. An even-odd effect in the fission process could be confirmed by a comparison of the y% values. The shape of the fission nucleus ^{236}U is discussed in terms of the dumbbell model. (82 figures, 66 tables, 145 references). (auth)

19991 NEUTRON MULTIPLICITY MEASUREMENT ON RESOLVED FISSION RESONANCES OF ^{235}U. Theobald, J. P.; Wartena, J. A.; Werz, R. (Commission of the European Communities, Geel, Belg.). J. Nucl. Energy; 27: No. 6, 435-439(Jun 1973).

Neutron induced fission events emitting 2, 3, 4 or 5 neutrons have different contributions to fission yields recorded with double

and triple neutron coincidence signals as a function of incoming neutron energy. This fact can be used to search for variations of neutron multiplicities in fission resonances, in particular, in resonances of different channel spins. In the case of ^{235}U no difference in fission neutron numbers for 3^- and 4^- levels has been detected above the experimental error of ±1.5%. (auth)

19992 SHELL STRUCTURE AND THE ASYMMETRY OF NUCLEAR FISSION FOR ^{240}Pu IN A STATISTICAL MODEL. Jensen, A. S. (NORDITA, Copenhagen); Damgaard, J. Nucl. Phys.; A210: No. 2, 282-296(1973).

The dependence on excitation energy of the mass distribution of the fragments arising from the fission of ^{240}Pu is studied in a statistical model. The level densities needed are calculated on the basis of the single-particle energies obtained from a deformed Woods–Saxon potential. When and how the shell effects disappear in ^{240}Pu with increasing excitation energy are investigated. Using the transition state method some characteristic properties of the fragment mass distributions are calculated and the results are compared with the experimental observations. Reasonable agreement is obtained. (auth)

19993 MEASUREMENT OF THE URANIUM-238 CAPTURE CROSS SECTION FOR INCIDENT NEUTRON ENERGIES UP TO 100 keV. de Saussure, G.; Silver, E. G.; Perez, R. B.; Ingle, R.; Weaver, H. (Oak Ridge National Lab., TN). Nucl. Sci. Eng.; 51: No. 4, 385-404(Aug 1973).

The neutron capture cross section of ^{238}U was measured for incident neutron energies between 5 eV and 100 keV by using a pulsed electron Linac neutron source and the time-of-flight technique. Capture gamma rays were detected by a large liquid scintillator located on a 40-m flight path. The incident neutron flux was monitored by a $^{10}BF_3$ ionization chamber. The cross section was normalized by the saturated resonance technique. The data have uncertainties which increase from ~5% at 1 keV to 10% at 100 keV. These data are compared with results from other measurements and with various evaluations. (auth)

19994 FISSION CROSS SECTION OF CALIFORNIUM-249. Silbert, M. G. (Los Alamos Scientific Lab., NM). Nucl. Sci. Eng.; 51: No. 4, 376-384(Aug 1973).

The neutron-induced fission cross section of ^{249}Cf was measured from 13 eV to 3 MeV. Neutrons from the Physics-8 underground nuclear explosion traversed a 240-m vertical evacuated flight path and interacted at ground level with a ^{249}Cf sample and with neutron flux monitors. Abundant fission was observed throughout the neutron energy region studied, although the several-MeV cross section was lower than expected on the basis of systematics. Forty-three resonances between 15 and 70 eV were parameterized using a multilevel R-matrix formalism. In this energy region, the average level spacing, corrected for five postulated unobserved levels, was 1.07 ± 0.14 eV, both spin states (4^-,5^-) of the compound nucleus being taken together. Assuming both spin states to have the same properties, the s-wave neutron strength function per spin state $\langle\Gamma_n^0\rangle/\langle D\rangle$ was $(1.5 \pm 0.3) \times 10^{-4}$. The average reduced neutron width $\langle\Gamma_n^0\rangle$ was 0.31 ± 0.08 MeV. For 35 well-defined resonances between 15 and 70 eV, the average fission width $\langle\Gamma_f\rangle$ was 180 MeV. (8 figures, 3 tables) (auth)

19995 GAMMA-RAY PRODUCTION CROSS SECTIONS OF NEUTRON INDUCED URANIUM-238 REACTIONS. Takahashi, H. (Brookhaven National Lab., Upton, NY). Nucl. Sci. Eng.; 51: No. 3, 296-315(Jul 1973).

The gamma-ray spectra produced by neutron-induced ^{238}U reactions are analyzed, primarily by using the statistical model, to provide the data for gamma-ray heating and shielding in the nuclear reactor. The gamma-ray spectra in low-energy neutron capture were calculated by taking into account the discrete and the continuous energy levels and E1, M1, E2, and M2 electromagnetic transitions. The transition probabilities for primary gamma rays were taken from the data of Price, et al. The calculated data are compared with John's experimental data and Yost's calculations. To calculate the gamma-ray spectra due to inelastic neutron scattering, the E2 and M1 transitions of the lowest 13 discrete levels of ^{238}U were calculated by using the rotational vibrational model of Bohr and Mottelson. The gamma production cross section due to fast-neutron reactions ($E_n > 2$ MeV) and the prompt gamma-ray spectrum due to fission were calculated by taking into account the yrast levels in the cascade process, as proposed by Thomas and Grover. The calculated prompt gamma-ray spectrum and the total gamma-ray production cross section are discussed in comparison with the experimental data. (15 figures, 16 tables) (auth)

Nuclear Theory

Refer also to abstracts 19638, 19801, and 19941.

19996 (ANU-P-568) SYMMETRY POTENTIAL FOR TRITONS. Nurzynski, J. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 171. 7p. Dep. NTIS (U.S. Sales Only) $3.00.

The elastic (t,t) scattering for $A > 40$ and $E_t = 20$ MeV was analyzed using the conventional optical model potential. The potential strengths were found to have a linear dependence on the symmetry term $(N - Z)/A$ with the average symmetry potentials $V_1 = 88.8$ MeV and $W_D^{(1)} = -5.04$ MeV. It is argued that the symmetry potentials for tritons cannot be associated with the $\underset{\sim}{t} \cdot \underset{\sim}{T}$ interaction. (1 figure, 1 table) (auth)

19997 (BNL-tr-541) STRUCTURE OF NEUTRON RESONANCES. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1973. Translation by S. J. Amoretty of JINR-P4-7046. (CONF-730538-2). 17p. Dep. NTIS $3.00.

From National Soviet conference on neutron physics; Kiev, USSR (28 May 1973).

A new approach to the study of the neutron resonance structure is considered; it is realized, first, by a general semimicroscopic description based on the operator form of the wave function, and, secondly, by numerical calculations within the model which take into account the interactions of quasi-particles with phonons. (3 figures) (auth)

19998 (FEI-257) EFFECT OF NEUTRON EMISSION ON FRAGMENT YIELDS, OBTAINED BY MEASURING THEIR ENERGIES. Tarasko, M. Z.; Kutsaeva, L. S.; D'yachenko, P. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 13p. (In Russian). INIS.

A method was developed for obtaining information on fission fragment yields, based on measurement of the kinetic energy of the fragments. An expression was derived for the energy/mass of the primary fragment — up until the ejection of the neutrons — $E_{ki}^{x}(m_i^{x})$, and the final fragment — after the emission of ν_i neutrons — $E_{ki}(m_i)$. It is essential to have available data on the dependence of the number of secondary neutrons on fragment mass $\bar{\nu}(m)$ in order to secure information on the yields and kinetic energy of the initial or final fragments. An Algol-60 program was written for fragment yields and the average total kinetic energy of the fragments as a function of their masses. Other factors indispensable to an analysis of the energy balance during fission were incorporated in the program. (tr-INIS)

19999 (FRNC-TH-353) UTILIZATION OF RANDOM MATRICES TO CALCULATE THE DENSITY OF THE LEVELS OF NUCLEAR SYSTEMS. Gervois, A. (Paris Univ. (France)). 1972. 117p. (In French). NTIS (U. S. Sales Only).

Thesis.

A statistical model is presented for studying the densities of nuclear levels. In the general case, where the interaction is non-negligible and does not possess obvious simplifications, the statistical properties of the spectrum are well reproduced by a group of partially or totally random matrices (the Wigner theory is adapted to a large energy range). In a first type of hypothesis, only the Hamiltonian invariances are known. The most studied problem is that of Gaussian distributions and their various generalizations; but, as in a certain number of cases only part of the Hamiltonian is known (mixing of several shells to describe a nucleus), the problem of partial random Hamiltonians is also studied. In the second formulation the invariances and the nature of the Hamiltonian (some of one- and two-body potentials) are considered simultaneously. A very detailed investigation of the level density of a realistic Hamiltonian was effected by French et al. for a single shell. This investigation demonstrated that the second theory is more nearly correct. French did not, however, show why the level density follows a normal law, or in what form the Hamiltonian intervenes. An attempt is made to answer this question. (FR)

20000 (IC-72/8) ROLE OF GAS–LIQUID PHASE TRANSITION IN THE THEORY OF NUCLEAR MATTER. Ramirez, S.; de Llano, M. (International Centre for Theoretical Physics, Trieste (Italy)). Mar 1972. 23p. INIS.

A sufficient condition for the two-nucleon interaction to produce a gaseous instability in the form of the appearance of inhomogeneous spatial density single-particle states of lower energy than the (homogeneous) plane-wave states is found to be simply that it gives binding in first order. The critical density at which the instability occurs thus signals the unambiguous breakdown of a plane-wave-based Hartree–Fock perturbation expansion for the ground state properties. Several examples are analyzed. (auth)

20001 (INR-1457) GIER–ALGOL 4 PROGRAM FOR THE STATISTICAL MODEL CALCULATIONS OF THE MULTISTAGE NUCLEAR REACTIONS. Grochulski, W.; Marcinkowski, A.

(Institute of Nuclear Research, Warsaw (Poland)). 1973, 68p. Dep. NTIS (U.S. Sales Only) $5.50.

A detailed description of the program ISOMER-4, calculating the cross sections, particle spectra, and the final state populations in nuclear reactions induced by nucleons in the framework of the statistical model, is given. (2 figures) (auth)

20002 (KFK-1730) COMPARISON OF MODELS FOR CALCULATING EXCITATION FUNCTIONS. Roehm, H. F.; Keller, K. A.; Muenzel, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). May 1973. 37p. Dep. NTIS (U.S. Sales Only) $4.00.

The comparison of models for calculating excitation functions was based on the deviations between calculated and measured excitation functions for about 180 different reactions, induced by neutrons, protons, ^{3}He and α particles, with target nuclei having proton numbers ranging from 13 to 92. In addition, input parameters and their influence on the form of excitation functions are discussed. (5 figures, 6 tables) (auth)

20003 (LA-5274-T) EXACT ANALYTICAL SOLUTION TO THE TWO-BODY PROBLEM WITH A SEPARABLE (NONLOCAL) CENTRAL AND TENSOR INTERACTION. Lee, C. E. (Los Alamos Scientific Lab., N. Mex.). Jul 1973. Contract W-7405-eng-36. 409p. Dep. NTIS $10.60.

Thesis. Submitted to Univ. of Colorado, Boulder.

A two-nucleon, nonrelativistic, spin-dependent and nonlocal interaction with a repulsive hard core (of diameter a) is investigated, and exact analytical solutions to the Schrodinger wave equation are obtained for all angular momentum states. Using a complete orthonormal set of functions on the interval (a,∞) the spatial and momentum representation wave functions are determined using contour integration techniques. The known identification of Blatt–Biedenharn, and also Stapp "bar", phase shifts from asymptotic spatial solutions permits determination of all phase-shift parameters in terms of known, explicitly displayed functions. The wave-function solutions, by further contour integration techniques, are also used in the explicit analytical determination of the deuteron bound-state condition, RMS radius and quadrupole moment. The low energy expansions of the S-wave phase-shift expressions for k cot δ result in a determination of the scattering length, effective range and shape-dependent parameters in terms of the core radius, and the strengths and ranges of the central and tensor interaction. Rapid computational methods using continued fractions to evaluate exponential integrals and series expressions with complex arguments are developed. Preliminary numerical calculations of the parameters of this exact analytical model are included. (auth)

20004 (LA-UR-73-972) CALCULATION OF FISSION BARRIERS FOR HEAVY NEUTRON-RICH NUCLEI. Howard, W. M.; Nix, J. R. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 20p. (CONF-730823-3; SM-174/60). Dep. NTIS $3.00.

From third symposium on physics and chemistry of fission; Rochester, New York, USA (13 Aug 1973).

The possible production of superheavy nuclei by the multiple capture of neutrons in the astrophysical r-process, the conventional thermonuclear explosion, and the multistep explosions proposed by Meldner is examined. This is done by calculating the fission barriers and neutron separation energies for the appropriate region of heavy neutron-rich nuclei through the use of an improved version of the macroscopic–microscopic method. The macroscopic energy is calculated according to the droplet model of Myers and Swiatecki, with constants they determined in January 1973 by adjustments to experimental nuclear ground-state masses and fission-barrier heights and from statistical calculations. The microscopic corrections to the energy are calculated from a diffuse-surface single-particle potential of the folded Yukawa type. The potential radius is taken from the statistical calculations of Myers; the potential well depths and diffuseness and the spin–orbit interaction strengths are adjusted to reproduce experimental single-particle levels in heavy nuclei. The calculated fission barriers are displayed as functions of the distance between the centers of mass of the two nascent fragments. The actual shapes considered are the sequence of idealized liquid-drop-model saddle-point shapes (the so-called y family of shapes) for distortions up to the vicinity of the saddle point. For larger distortions the most probable idealized liquid-drop-model dynamical path is used. The neutron separation energies are calculated from ground-state masses that are determined by minimizing the potential energy with respect to the nuclear quadrupole moment, Q_2, and hexadecapole moment, Q_4. For a broad region of heavy neutron-rich nuclei the calculated fission barriers are less than the calculated neutron separation energies. This stems primarily from the predicted rapid decrease in the effective surface tension of a nucleus with increasing neutron excess. The capture of a neutron, therefore, should excite the nucleus above the top of the fission barrier, and, consequently, terminate the neutron-capture process before any superheavy nuclei are produced. (8 figures) (auth)

20005 (LA-UR-73-981) DYNAMICS OF FISSION AND FUSION WITH APPLICATIONS TO THE FORMATION OF SUPERHEAVY NUCLEI. Sierk, A. J.; Nix, J. R. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 23p. (CONF-730823–10; SM–174/74). Dep. NTIS $3.25.

From 3rd symposium on physics and chemistry of fission; Rochester, New York, USA (13 Aug 1973).

Various aspects of the dynamical evolution of nuclei are studied in the framework of the liquid drop model: the effects of viscosity on the separation of fission fragments, the fission of very large nuclei, and the fusion of two heavy ions. As the viscosity increases, the fragments remain prolate for a longer time. The dynamical path from an initially spherical configuration to scission is calculated for nuclei with fissility parameter between 1.0 and 1.6. As the Coulomb energy increases, the scission configuration becomes more and more elongated. At scission the length of the $^{476}184$ nucleus, formed from two ^{238}U nuclei, is about 14 times the diameter of the initial sphere; thus, the nucleus would probably fission into three or more fragments if this were allowed by the shape parametrization. The static potential energy of two tangent spheroidal fragments of the $^{476}184$ nucleus corresponding to $^{300}116$ and ^{176}Er is computed. Configurations stable against fission of the $^{300}116$ nucleus have an energy over 100 MeV higher than the minimum energy of two tangent spheroids and the energy of the scission point. Single-particle effects lead to a small local minimum in the potential energy near the spherical heavy fragment with a barrier of about 4 MeV against prolate distortions. It is concluded from these results that the fusion–fission reaction of very heavy ions is not likely to produce superheavy nuclei. The fusion reactions of two initially spherical tangent nuclei are studied at various incident energies above the interaction-barrier height. The amount of incident energy necessary for symmetric systems to fuse to a configuration more compact than the liquid-drop-model saddle-point shape is calculated as a function of fissility parameter. As specific examples the symmetric reactions ^{110}Pd + ^{110}Pd and ^{238}U + ^{238}U are considered. (10 figures) (RWR)

20006 (LA-UR–73-1036) CALCULATION OF FISSION BARRIERS. Moeller, P.; Nix, J. R. (Los Alamos Scientific Lab., N. Mex.). 1 Aug 1973. Contract W-7405-eng-36. 50p. (CONF-730823–7; SM–174/202). Dep. NTIS $4.50.

From 3rd symposium on physics and chemistry of fission; Rochester, New York, USA (13 Aug 1973).

Advances in the calculation of the nuclear potential energy of deformation are reviewed, including both self-consistent microscopic methods and the macroscopic–microscopic method. In the latter method, particular attention is paid to specifying the nuclear shape, calculating the macroscopic (liquid-drop) energy, generating the single-particle potential, solving the Schroedinger equation, and calculating the microscopic (shell and pairing) corrections. New calculations done at LASL are presented. Nuclear shapes are specified in terms of smoothly joined portions of three quadratic surfaces of revolution. The macroscopic energy is calculated from the droplet model. Microscopic shell and pairing corrections are calculated by means of Strutinsky's method from the single-particle levels of a diffuse-surface folded Yukawa single-particle potential. Such calculations help provide an understanding and unification of many varied phenomena associated with nuclear shape changes. (18 figures, 107 references) (RWR)

20007 (N-73-19704) SELF-CONSISTENT PAULI CORRECTIONS IN BRUECKNER–HARTREE–FOCK CALCULATIONS. Braley, R. C.; Ford, W. F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1972. 12p. (NASA-TM-X-68197). NTIS.

A scheme is introduced which makes it feasible to make completely self-consistent Brueckner–Hartree–Fock (BHF) and renormalized BHF calculations for spherical, closed-shell and axially-symmetric deformed nuclei. The usual requirement or orbital self-consistency was imposed, as well as self-consistency in the starting energies and occupation probabilities. Previously, only approximate forms were used for the Pauli operator. This approximation is removed and a method for making the necessary Pauli corrections to the reaction matrix during the approach to self-consistency is presented. A discussion of the symmetries which reduce the problem to one of manageable proportions is included. (auth)

20008 (NIIAR-P-132) POSSIBLE NATURE OF SOME O^+ STATES OF SPHERICAL NUCLEI. Vinogradov, B. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1972. 15p. (In Russian). INIS.

The excitation spectrum of O^+ levels for spherical nuclei, which

had been obtained by configuration interactions, were examined. Allowance was made for those configurations which were distinguished from the fundamental transfer of two particles. (tr-auth)

20009 (ORNL-tr-2701) USE OF THE JACKSON–SIKKELAND METHOD FOR CALCULATING PRODUCTION CROSS-SECTIONS FOR SUPERHEAVY ELEMENTS. Il'inov, A. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1973. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.) from JINR-P7-7108. 14p. Dep. NTIS $3.00.

The possibilities of the semiempirical Jackson–Sikkeland method, used very often for calculation of production cross-sections for superheavy elements in heavy-ion-induced reactions, were studied. The method describes well the shape of the excitation function of the reaction with x-neutron emission; the absolute cross-section values agree best with experiment for the reaction with $x = 4.5$ (with an accuracy up to a factor of $k = 2$). This accuracy decreases when extrapolating to the region of new elements with $Z \geq 106$ and especially for the 5n-reaction. (auth)

20010 (ORO–4317-21) SINGULAR CORES IN THE THREE-BODY PROBLEM. II. Numerical Solution. Technical Report No. 73-119. Brayshaw, D. D. (Maryland Univ., College Park. Dept. of Physics and Astronomy). May 1973. 23p. Dep. NTIS $3.25.

The formalism for singular cores previously introduced is investigated numerically for a simple model. Calculations of three-particle binding energies and the analog of N–d scattering for this model demonstrate the practicality of the earlier theoretical development. (auth)

20011 (ORO–4317-23) THEORY OF THE PION-NUCLEUS OPTICAL POTENTIAL. Cammarata, J. B.; Banerjee, M. K. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Jun 1973. 13p. (CONF-730642-2). Dep. NTIS $3.00.

The role of pion-nucleus crossing in the construction of an optical potential is discussed, and it is shown that crossing has a significant effect on the cross sections and the elastic scattering wave functions of low energy pions. (auth)

20012 DEPENDENCE OF OPTICAL-MODEL PARAMETERS ON ISOSPIN. Cotanch, S.; Robson, D. (Princeton University, Princeton, New Jersey 08540). Phys. Rev. C 7: No. 4, 1714-1716 (Apr 1973).

Global optical-model parameters describing quasielastic reactions are examined. Such potentials, particularly the absorptive components, do not in general conserve isospin. A prescription is offered in an attempt to provide a guideline for deducing optical parameters which do not violate isospin. (auth)

20013 SOLVABLE MODEL FOR DESCRIBING QUASI-ROTATIONAL BANDS IN TRANSITIONAL NUCLEI. Krumlinde, J. (Lund Inst. of Tech., Sweden); Marshalek, E. R. Lett. Nuovo Cim.; 7: No. 14, 679-684(4 Aug 1973).

The plot of the moment of inertia as a function of ω^2 is used for the comparison of a simple solvable model, which is suggested for the quasi-rotational bands of transitional nuclei, with experiment. (JFP)

20014 ABSORPTION MECHANISM OF PIONS AND NUCLEAR CORRELATION. Futami, Y. (Science Univ. of Tokyo); Hiramoto, T. Progr. Theor. Phys. (Kyoto); 49: No. 2, 524-530(Feb 1973).

The absorption mechanism of pions on nucleon pairs in a nucleus are studied from a more fundamental point of view. The importance of nuclear correlation is emphasized. The effective absorption operator taking into account the final state interaction is introduced. (auth)

20015 APPROXIMATE USE OF THE COMPLEX GAMMA FUNCTION IN SOME WAVE PROPAGATION PROBLEMS. Heading, J. (University Coll. of Wales, Aberystwyth). J. Phys., A (London); 6: No. 7, 958-973(Jul 1973).

After a historical survey of the problem of the potential barrier, and an examination of the types of approximations introduced and the reason for them, certain fallacious processes are discussed whereby the complex gamma function is given false approximate representations by means of exponential functions. Two kinds of problems involving complex barriers are then examined; firstly, the phenomenon of resonant tunnelling through two complex potential barriers, and, secondly, reflection phenomena arising from a single complex barrier. The common fallacies are also examined, and the proper treatment of these problems shows when the complex gamma function must be retained and when it can be dispensed with. (auth)

20016 FINAL-STATE INTERACTION BETWEEN THE Λ^0-HYPERON AND RESIDUAL NUCLEUS R_3 IN THE REACTION $K^- + {}^4He \rightarrow \pi + \Lambda^0 + R_3$. I. Single-Channel Calculation. Iwamura, Y. (Science Univ. of Tokyo). Progr. Theor. Phys. (Kyoto); 49: No. 2, 507-523(Feb 1973).

For the reaction $K^- + {}^4He \rightarrow \pi + \Lambda^0 + R_3$ (residual nucleus), the investigation of the final Λ^0-R_3 interaction and its spin-dependence is performed in the framework of the single-channel (i.e., without the $\Sigma - \Lambda$ conversion) Omnès equation whose Born term is given by the impulse approximation. The calculation is carried out for the nuclear capture of K^- meson at rest from both the 1S and 2P atomic states. It turns out that the effect of singlet Λ^0-R_3 rescattering has considerable influence on the pion momentum distributions, while the triplet one is small. In the theory used in this article, the refinement is performed so that the parameter-search may be carried out over all. (auth)

20017 MULTISTAGE ASPECTS OF THE THEORY OF STRIPPING REACTION INVOLVING SPHERICAL DEFORMED NUCLEI. Luk'yanov, V. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 4, 870-875(Apr 1972). (In Russian).

The multistage aspects of the theory of A(d,p)B stripping reactions related to the participation of low collective levels of the A and B nuclei were considered within the framework of the so-called generalized method of distorted waves. In order to simplify the relations, the double adiabatic approximation was used; it involved the approximate decomposition of the multi-channel wave function into partial waves. The calculations indicated that the higher levels of the stripping may play an important role in the permissible transitions, as far as the angular distribution and absolute cross-sections are concerned. This could be confirmed by numerical calculations. The forbidden transitions are purely two-stage phenomena. (TTT)

20018 EXTENSION OF THE SINGLE-PARTICLE DESCRIPTION IN NUCLEAR SYSTEMS. I. General Theory in Truncated Space. Suzuki, K. (Kyushu Inst. of Tech., Fukoka). 49: No. 3, 852-876(Mar 1973).

A general theory is proposed for the study of the single-particle description of a non-degenerate finite-particle system in a truncated shell-model space. In this theory, it is established that one can introduce a single-particle representation satisfying the requirements that single-particle operators to be defined should obey the fermion-commutation relation, and that the corresponding free vacuum should also be the lowest eigenstate of the Hamiltonian. It is proved that such a representation based on the true ground state can be derived by the unitary transformation of the usual fermion operators similarly to the quasi-particle transformation method. The equation is given for the determination of the unitary operator proper to new representation. This approach is proved to be understood as a natural extension of the usual Hartree-Fock theory. The theory is applied to a normal system, and a successive linearization procedure is proposed in order to solve the equation for the unitary operator. The advantages of the theory are discussed in connection with the nuclear shell-model problems. (auth)

20019 RELATIVISTIC CORRECTIONS TO NUCLEAR MAGNETIC MOMENTS AND GAMOW–TELLER MATRIX ELEMENTS OF BETA DECAY. Ohtsubo, H.; Sano, M.; Morita, M. (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 3, 877-884(Mar 1973).

The relativistic motion of a nucleon inside the nucleus is described by the Dirac equation with an effective potential of the scalar or vector type. Possible relativistic corrections to nuclear magnetic moments and Gamow–Teller matrix elements of beta decay are investigated theoretically. (auth)

20020 CHARGED VALUES IN FISSION FRAGMENTS. Ghani, A.; Rubbani, A. (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). J. Phys. Soc. Jap.; 34: No. 4, 845-847(Apr 1973).

It is proposed that the fissioning nucleus, at the instant before scission, can be represented by the two fragment nuclei interacting through a thin neck having the most probable structure of a deuteron. As the first approximation, the charge density of both the fragment nuclei is considered to be the same as determined by electron–nucleus scattering data. At scission the proton from the neck coalesces with the light fragment to release the maximum possible energy in the transition. The model gives the most probable charge values, Z_p, which are consistent with the recently compiled results of Wahl et al., and the weighted average values given by Pappas et al. The model also proposes the mechanism of the charge dispersion phenomenon. (auth)

20021 α-EMISSION BY PRE-EQUILIBRIUM PROCESSES IN (n,α) REACTIONS. Milazzo-Colli, L.; Braga-Marcazzan, G. M. (CISE, Milan). Nucl. Phys.; A210: No. 2, 297-306(1973).

The existence of a pre-equilibrium emission mechanism in the (n,α) reaction on nuclei with $A > 90$ is shown. Both the α-spectrum shape and excitation function can be fitted by considering a contribution from this reaction mechanism and, in lighter nuclei, from statistical evaporation. From a fitting of the absolute values

of the cross sections a parameter φ is extracted, having the physical meaning of the probability for the incoming particle to strike a preformed α-cluster. (auth)

20022 PHASE TRANSITION IN NUCLEAR MATTER AND MULTIPARTICLE NUCLEAR FORCES. Migdal, A. B. (Landau Inst. for Theoretical Physics, Moscow). Nucl. Phys.; A210: No. 2, 421-428(1973).

The π-meson spectrum in nuclear matter for N = Z is obtained. It is shown that there are two branches of the meson spectrum. At a density which is less than the nuclear one, an instability of the meson field appears, leading to a phase transition which changes the energy of the ground state of the nucleus and gives an additional specific meson and electron scattering by nuclei. The distortion of the meson Green function in nuclear matter affects appreciably the internucleon forces. This effect cannot be described with the usual assumption of a pair interaction. (auth)

20023 COMPILATION AND ANALYSIS OF INTERMEDIATE- AND HIGH-ENERGY PHOTON AND ELECTRON INDUCED SPALLATION YIELDS. Jonsson, G. G.; Lindgren, K. Phys. Scr.; 7: No. 1-2, 49-54(1973).

Available intermediate- and high-energy photon and electron induced spallation yields have been compiled and analyzed with the five-parameter formulas given by Rudstam. The mass and energy dependence of the parameters are discussed. With appropriate parameters the CDMD-formula is then used to estimate spallation yields and cross sections. (auth)

20024 SINGLE PARTICLE ENERGY-LEVEL DENSITIES IN VARIOUS NUCLEAR POTENTIAL WELLS. Horng, I. C.; Chang, P. H. (Tatung Inst. of Tech., Taiwan). Tai-Wan K'o Hsueh; 25: No. 1-2, 5-11(1971). (In Chinese).

An improved method for calculating nuclear level densities which includes angular momentum effects is demonstrated. Calculations are performed for a Malenka–Green potential well, square well, exponential potential well, Gaussian potential well, and a simple harmonic oscillator. The Malenka–Green potential well shows the best agreement with experimental level densities. (JWR)

20025 MAGNETIC MOMENTS AND BETA-DECAY RATES OF LIGHT NUCLEI. Shimizu, K. Stony Brook, NY; State Univ. of New York (1972). 225p. University Microfilms Order No. 73-16,062.

Thesis (Ph.D.).

The magnetic moments and the beta-decay matrix elements of nuclei with the ^{16}O core plus (minus) one nucleon and the ^{40}Ca core plus (minus) one nucleon are studied primarily from the point of view of configuration mixing. The contribution from the second order is calculated up to configurations with $2\hbar\omega$ excitations by using the G matrix (calculated by Kuo in the ^{16}O core and calculated by Kuo and Brown in the ^{40}Ca core). However, the corrections to the matrix elements of the G-T interaction are too small to explain the observed values. Because a tensor force causes admixtures of higher configurations, the second order corrections due to the tensor force are summed up to $12\hbar\omega$ in the ^{16}O core and $10\hbar\omega$ in the ^{40}Ca core. This effect is extremely important in reducing the matrix elements of the G-T interaction. In the second order calculation at least two mesons are involved. There is another process which involves two mesons; the tensor force excites the single particle states to high energy intermediate states which the Sachs moment brings back to the single particle states. This process is found to be appreciable and comparable with the zeroth order contributions of the Sachs moment (the matrix elements of the Sachs moment in the single particle states). As a result, it is found that the second order configuration mixing and the exchange current make competitive contributions to the magnetic moments so that the net results become small. These results are consistent with the experimental results. (Diss. Abstr. Int., B)

20026 NUCLEAR MAGNETIC MOMENTS AND EXCHANGE CURRENTS. Hyuga, H. Stony Brook, NY; State Univ. of New York (1972). 260p. University Microfilms Order No. 73-15,895.

Thesis (Ph.D.).

The effect of exchange currents on magnetic moments is studied from phenomenological and field-theoretic points of view up to the two-pion-exchange range. In the phenomenological approach, the Sachs moments due to the one-pion exchange and the Hamada–Johnston potential are investigated. In addition, the effective Sachs moments, which partially correspond to the first-order perturbation correction to the Sachs moments, are found to be important for a range of nuclei. For the field-theoretic approach, the one-pion and the vector-meson exchanges are found to agree well with the Sachs moment derived from the Hamada–Johnston potential. In addition, for a two-pion-exchange process which is independent of the rho-meson exchanges, inelastic channel processes caused by the nucleon resonance N* are found to be very important. As a result, it is found that the Sachs moment (the orbital g-factor correction) and the inelastic channel coupling (the spin g-factor correction) make coherent contributions to the magnetic moment of the spin-parallel states and cancelling contributions to that of the spin–antiparallel states. Since the second-order perturbation corrections have a similar character but opposite sign to the exchange magnetic moment, it is found that the spin g-factor and the orbital g-factor corrections due to the exchange currents tend to cancel with the spin g-factor and the orbital g-factor due to the second-order perturbation corrections, respectively. The effects of the exchange currents on the electric dipole sum rule as well as the GT-type beta-decay matrix element are briefly discussed and found to be important. (Diss. Abstr. Int., B)

20027 MULTIPLE REACTION CORRECTION TO NEUTRON REACTION CROSS SECTIONS. Devaney, J. J. (Los Alamos Scientific Lab., NM). Nucl. Sci. Eng.; 51: No. 3, 272-277(Jul 1973).

The importance of the multiple-reaction correction to cross sections above ~0.1 MeV is demonstrated by deriving a simple formula for a thin-slab sample by utilizing a limited multigroup, spatially averaged, transport theory, and applying the formalism to a few examples. To illustrate the immediate relevance of the correction, it is also applied to revise an important cross section in current use, (^{238}Uσ_{ny}, ENDF/B-III). The correction can be large with thicker samples and at higher energies, especially for radiative capture (exceeding a factor of 10). These examples indicate that multiple reaction effects must be checked in measuring or evaluating radiative capture, fission, reaction, and gamma production cross sections and their consequent spectra. (1 figure, 2 tables) (auth)

20028 (EANDC(E)–157-U(Vol.1), pp 9-11;13) STUDY OF THE OPTICAL POTENTIAL FROM NEUTRON STRENGTH FUNCTION SYSTEMATICS. Newstead, C. M. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1973.

PHYSICS (PLASMA AND THERMONUCLEAR)

Refer also to abstract 20092.

20029 PLASMA PHYSICS INDEX. Volume 8, No. 6, 1973. Bibliography, Author Index, Subject Index. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). 156p.
This listing includes 378 references. (MOW)

20030 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. Volume 7, No. 5, 1973. Bibliography, Author Index, Subject Index, Appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). 54p.
This listing includes 260 references. (MOW)

Confinement and Heating

20031 (AD-757228) EXPERIMENTAL STUDY OF THE FEASIBILITY OF INERTIALLY CONFINING ENERGETIC ELECTRONS AND IONS BY ELECTROSTATIC MEANS. Final Report, 1 July 1968-31 December 1972. Verdeyen, J. T.; Cherrington, B. E. (Illinois Univ., Urbana. Dept. of Electrical Engineering). Feb 1973. 54p. (UILU-ENG-73-2546; AFOSR-TR-73-438). NTIS.

Experimental studies of the potential and the electron density inside inertial electrostatic plasma confinement devices were performed using electron beam, microwave, and laser diagnostic techniques. A distinctly oscillatory variation of the electron density as a function of radius was found in the cylindrical device for electron and ion injection into a low-pressure deuterium gas background. Electron injection into a hard vacuum was found to produce a deep potential well in the spherical device, whereas electron injection into a low-pressure gas was found to create steady-state alternating potential wells. (auth)

20032 (CONF-720705-) PROCEEDINGS OF THE FIRST TOPICAL CONFERENCE ON rf PLASMA HEATING. Conference Held at Lubbock, Texas, July 6-8, 1972. (Texas Tech Univ., Lubbock. Plasma Lab.). Jul 1972. 237p.

From 1st topical conference on rf plasma heating; Lubbock, Texas, USA (6 Jul 1972).

Separate abstracts were prepared for 27 of the 34 included papers. The 7 remaining papers appeared previously in NSA: see NSA, 26: 42253, 54750, 54751, and 54805; 27: 13777 and 23645; and 28: 9737. (MOW)

For abstracts of individual papers see: 20033-20052, 20059, 20068, 20069, and 20118-20121.

20033 (CONF-720705-, pp A1-1-A1-6) RADIO-FREQUENCY HEATING OF A COLLISIONLESS PLASMA. Abrams, R. H. Jr.; Ohe, T.; Lashinsky, H. (Univ. of Maryland, College Park). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Large-amplitude, intermediate-frequency electric fields are used to heat a collisionless plasma in experiments performed in a single-ended Q machine. Ion-acoustic waves and turbulence are excited over a range of rf field frequencies near the ion plasma frequency. Above an excitation threshold, both the ion-acoustic wave frequency and the electron temperature (measured by probes) increase with increasing rf level. Several proposals that may explain the experimental results are described, and a possible fusion application of externally controlled ion-acoustic turbulence is presented. (auth)

20034 (CONF-720705-, pp A2-1-A2-6) ION HEATING FOLLOWING THE DESTRUCTION OF LARGE-AMPLITUDE ION ACOUSTIC WAVES. Judice, C. N. (Bell Labs., Whippany, NJ). Jul 1972.

From first topical conference on RF plasma heating, Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Using a hybrid PIC code that treats ions as finite size, weighted particles and electrons as an inertialess, isothermal fluid, large-amplitude ion acoustic waves were launched in a one-dimensional, unmagnetized plasma. Computer experiments were performed over a broad spectrum of wavelengths, amplitudes, and temperature ratios demonstrating a laminar and turbulent regime for nonlinear ion acoustic wave propagation. (auth)

20035 (CONF-720705-, pp A4-1-A4-6) rf PLASMA HEATING BY THE MODIFIED TWO-STREAM INSTABILITY. Ott, E.; McBride, J. B. (Naval Research Lab., Washington, DC). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Theory and computer simulation has shown the potential importance of the modified two-stream instability as an ion heating mechanism in low-β plasmas. To take advantage of the ion heating which it can produce, one considers inducing the instability with large-amplitude waves. Since the instability is driven by electron-ion drifts across a magnetic field, and has a frequency comparable to the lower hybrid frequency, a natural choice for the driver is a magnetosonic wave. It is demonstrated that for the parameters of the Princeton ST-Tokamak it is theoretically possible to achieve thermonuclear temperatures by anomalously absorbing these waves. (auth)

20036 (CONF-720705-, pp A5-1-A5-5) ANOMALOUS HEATING OF PLASMA BY MAGNETO-ACOUSTIC WAVES IN FREQUENCY DOMAIN $\omega_{ci} < \omega < \sqrt{\omega_{ci}\omega_{ce}}$. Finken, K. H.; Stampa, A.; Tuczek, H. (Kernforschungsanlage, Juelich, Ger.). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

The heating of plasma by fast magnetoacoustic waves which are excited in a plasma by rf waves with frequencies larger than the ion cyclotron frequency ω_{ci}, $\omega_{ci} < \omega < \sqrt{\omega_{ci}\omega_{ce}}$, is investigated. The structure of the waves is studied by probes and laser light scattering. The results of the measurements compared to calculations confirm that the energy transfer can only be explained by assuming an anomalously increased resistance. (auth)

20037 (CONF-720705-, pp A6-1-A6-5) ENHANCED ENERGY TRANSFER TO A CYLINDRICAL PLASMA BY AN ALFVEN WAVE. Lancaster, D. B.; Hagler, M. O.; Kristiansen, M. (Texas Tech Univ., Lubbock). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

An enhanced transfer of 3.8-MHz rf energy to both hydrogen and deuterium plasmas was observed during a ringing theta discharge with a quasi-steady axial-bias magnetic field. The transfer occurs during approximately one rf cycle for particular combinations of the initial gas pressure and the bias magnetic field. The percentage of energy transferred is relatively independent of both the density and the initial energy stored in the theta-discharge capacitor and is accompanied by a change in the ringing frequency of the external circuit. The peak field due to the fast theta discharge is 0.18 T. The bias field is variable from 0 to 0.45 T. (auth)

20038 (CONF-720705-, pp B3-1-B3-5) CYCLOTRON HEATING OF PLASMAS WITH FINITE-AMPLITUDE WAVES. Swanson, D. G.; Oei, I. H.; Clark, R. W. (Univ. of Texas, Austin). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

Proceedings of the first topical conference on rf plasma heating.

The original attempts to understand cyclotron resonance effects with the associated heating of plasmas quite properly undertook to describe the waves with linear plasma wave theory. With respect to cyclotron heating, linear theory allows the usual ion cyclotron wave whose phase velocity is parallel to the magnetic field and two kinds of electrostatic waves whose phase velocity is oblique to the field. For harmonic ion cyclotron wave heating, electrostatic waves are required by linear theory and studies of the properties of the two types of waves were made, with comparisons with experiments showing little success to date in identifying the waves. It is proposed that in essentially collisionless plasmas, nonlinear effects so dominate the plasma that linear theory is of little use for finite amplitude heating. Some implications of this proposal in relation to experiments are discussed. (auth)

20039 (CONF-720705-, pp B5-1-B5-7) OPERATING FEATURES OF AN ION-CYCLOTRON-WAVE PLASMA APPARATUS

RUNNING IN THE RF-SUSTAINED MODE. Swett, C. C. (Lewis Research Center, Cleveland). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

An experimental study was made of an ion-cyclotron-wave apparatus operated in the rf-sustained mode, i.e., a mode in which the Stix rf coil both propagates the waves and maintains the plasma. Problems associated with this method of operation are presented. Some factors that are important to the coupling of rf power are noted. In general, the wave-propagation and wave-damping data agree with theory. Some irregularities in wave fields are observed. Maximum ion temperature is 870 eV at a density of 5×10^{12} cm^{-3} and rf power of 90 kW. Coupling efficiency is 70%. (auth)

20040 (CONF-720705-, pp B6-1-B6-6) RF HEATING OF MAGNETICALLY CONFINED ARC PLASMA. Nielsen, C. E. (Ohio State Univ., Columbus). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

Proceedings of the first topical conference on rf plasma heating.

Stable fully ionized helium plasma is produced by repetitively pulsed arc current flowing parallel to a 3-kG magnetic field between an incandescent tungsten cathode and a water-cooled anode. A 3-MHz pulsed oscillator coupled to the plasma through a coaxial cathode structure produces waves characterized by radial electric field and net azimuthal current. Propagation and attenuation of these waves along the plasma column are observed by pickup loops external to the plasma. Azimuthal current densities in the kiloampere/cm^2 range are associated with the waves produced by oscillating radial electric fields of hundreds of volts/cm. Waves of ~3 MHz, which is ~3 times the He^+ gyrofrequency, are attenuated to ~0.1 amplitude in 10 cm, a distance of the order of the wavelength. (auth)

20041 (CONF-720705-, pp B7-1-B7-3) QUADRUPOLE CYCLOTRON HEATING AND CONFINEMENT. Arendt, P. N.; Pool, M. L. (Ohio State Univ., Columbus). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Quadrupole electric fields are inwardly convexed within a continuous magnetized cyclindrical plasma. The frequency of the fields is near that of the ion gyromagnetic frequency. Computations yield: 1) indefinitely long radial ion retainment times, 2) stochastic ion heating, 3) an arbitrary keV ceiling on ion energies, 4) simultaneous energization of two or more particles (^{2}H, ^{3}H, ^{4}He) in the same plasma volume, and 5) impediments to energetic ions tending to impinge on container walls. (auth)

20042 (CONF-720705-, pp C2-1-C2-4) NONLINEAR THEORY OF PLASMA HEATING BY PARAMETRIC INSTABILITIES. Weinstock, J.; Bezzerides, B. (National Oceanic and Atmospheric Administration, Boulder, CO). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

A theoretical calculation is made of the rate of heating of electrons and ions by the application of rf near the plasma frequency. The heating mechanism is due to the parametric instability. That is, for sufficiently intense rf, the parametric instability causes Langmuir and ion acoustic waves to grow. The Langmuir waves accelerate and heat electrons and, for $T_e >> T_i$, the ion acoustic waves accelerate and heat ions. The saturated intensity of these waves and the resulting heating is quantitatively predicted. (auth)

20043 (CONF-720705-, pp C3-1-C3-7) PARAMETRIC HEATING OF DENSE PLASMAS WITH 890-GHz RADIATION. Jassby, D. L. (Univ. of California, Los Angeles). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

The threshold intensity of 0.337-mm HCN-laser radiation (890 GHz) for excitation of the parametric decay instability in a collisional low-temperature plasma is 10^6 W/cm^2 at the cutoff layer. An experimental setup for investigation of the decay instability in a steady-state overdense arc plasma at T = 1.5 to 4.0 eV using a high-power pulsed HCN laser is described. (auth)

20044 (CONF-720705-, pp C7-1-C7-5) NUMERICAL INVESTIGATION OF NONRESONANT rf-SUPPLEMENTED MIRROR CONTAINMENT. Gray, E. P. (Johns Hopkins Univ., Baltimore). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Single-particle trajectory calculations were carried out to test and extend Watson and Kuo-Petravic's suggestion for enhancing charged particle containment in magnetic mirrors by adding a nonresonant rf field in such a way as to increase the particle's transverse energy in a reversible manner. It was found that particle confinement can be improved drastically without rf absorption. For example, for a particular configuration studied, it takes an electric field strength of about 120 volts/cm to confine a 100-eV proton about to escape from a magnetic mirror whose midplane field strength is 5000 gauss, with a mirror ratio of 1.5. (auth)

20045 (CONF-720705-, pp C8-1-C8-6) rf-ASSISTED MAGNETIC MIRRORS. Little, P. F.; Van Essen, L. J.; Howell, R. B. (Univ. of Texas, Austin). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Computations of the path of potassium ions in combined rf electric and static magnetic fields are compared with observations on a single magnetic mirror. The small electric field components along the magnetic field are found to be important. Preliminary experiments with plasma are in progress. (auth)

20046 (CONF-720705-, pp D1-1-D1-16) LOWER-HYBRID HEATING IN ALCATOR. Thomassen, K. I.; Briggs, R. J.; Parker, R. R.; Simonutti, M. D. (Massachusetts Inst. of Tech., Cambridge). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

A proposed plasma heating experiment on the M. I. T. Tokamak, ALCATOR, is described. An 80-kW microwave source at the lower hybrid frequency f_{pi} = 2450 MHz is coupled to the torus through a coupling aperture on the outer circumference. Pulse lengths to 200 msec are available and the output can be modulated at frequencies to 500 kHz. Propagation to the lower hybrid resonance layer, the nature of the aperture impedance, possible heating mechanisms, and potential feedback schemes are discussed. (auth)

20047 (CONF-720705-, pp D5-1-D5-6) LOWER-HYBRID RESONANCE HEATING OF A PLASMA IN A PARALLEL-PLATE WAVEGUIDE. Puri, S.; Tutter, M. (Max-Planck Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Wave propagation in a parallel-plate metallic waveguide partially filled with an inhomogeneous, anisotropic plasma column is studied as an eigenvalue problem using the complete cold-plasma dielectric tensor. Although the accessibility condition is not met, the collisional energy absorption at the lower-hybrid resonance greatly exceeds the resistive loss at the waveguide walls resulting in a very high plasma-heating efficiency. Detailed numerical results for the heating efficiency, energy flux into the plasma, energy density and dissipation density in the plasma column, as well as group velocity, are presented. Also the effects of density profile, collision frequency, and waveguide eigenmodes are discussed. (auth)

20048 (CONF-720705-, pp D6-1-D6-6) rf HEATING OF PLASMAS WITH TWO ION COMPONENTS. McBride, J. B.; Ott, E.; Orens, J. H. (Naval Research Lab., Washington, DC). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

A theoretical and computer simulation treatment is presented for the response of magnetized plasmas with two ion species to low-frequency, electric fields oscillating at ω_0 near the lower hybrid frequency ω_{LH} that shows the existence of parametric instabilities. A decay instability involving the Buchsbaum two-ion resonance occurs for $\omega_0 > \omega_{LH}$, and a purely growing instability

occurs for $\omega_0 < \omega_{LH}$. The analysis is valid even when the masses of the ion components are comparable and applies, for example, to deuterium–tritium plasmas. Computer-simulation experiments demonstrate the potential importance of these instabilities as ion-heating mechanisms. (auth)

20049 (CONF-720705-, pp E2-1-E2-7) MICROWAVE HEATING OF HOT-ELECTRON PLASMA IN THE SUPERCONDUCTING LEVITRON. Anderson, O. A.; Birdsall, D. H.; Hartman, C. W.; Hooper, E. B. Jr.; Munger, R. H. (Lawrence Livermore Lab., CA). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Hot-electron plasma ($n \simeq 10^8$ to 10^{10} cm^{-3}, $T \simeq 100$ to 500 keV) heating by microwaves is studied in closed sheared magnetic-field configurations having either tokamak-like trapping, minimum $\partial B/\partial s$, or trapping in minimum $|B|$. Heating at 8.6 to 10.6 GHz is used at powers up to 15 kW and durations of 10 msec to several seconds. The energy buildup rate and limiting β (about 2×10^{-2}) for the hot electron plasma are relatively insensitive to field configuration and appear to be determined by cold plasma production. For the first two configurations some heating at magnetic surfaces where $B = B_{ECR}$ is observed; however, the hot electron density is maximum on surfaces where $B < B_{ECR}$ suggesting either over-cyclotron-resonance heating or rapid transport from the resonance zone by oscillations during the heating. Since $n \ll n_{cutoff}$, any shift of the heating zone is presumably not associated with the upper hybrid frequency. (auth)

20050 (CONF-720705-, pp E3-1-E3-6) PLASMAS IN TOROIDAL CAVITIES. Hatch, A. J.; Sanders, S. G.; Robinson, J. (Argonne National Lab., IL). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

The frequency and Q of several fundamental normal modes in an empty sectored toroidal cavity were measured. Mode splitting resulting from the toroidal shape and from imperfections in the sectored structure was observed. Low-density plasmas have been produced by cw uhf power up to 1 kW in a glass vacuum liner, and the resulting frequency shifts of the normal modes were measured. The mode spectrum with an inner metallic core simulating a high-density plasma was also measured. The results are potentially applicable to the problem of coupling rf heating power to a toroidal plasma. (auth)

20051 (CONF-720705-, pp E4-1-E4-6) APPROXIMATE MODELS OF TOROIDAL CAVITIES. Sanders, S. G.; Hatch, A. J.; Robinson, J. (Argonne National Lab., IL). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

A sectored toroidal rf cavity was approximated (a) as a cylindrical cavity with a length equal to the mean circumference of the torus, and (b) as a ring cavity obtained by capping the ends of a short section of coaxial waveguide. A modification of the coaxial model is found to yield good agreement with experimental measurements on the sectored torus. The method of calculation is applied to cavities having nominal dimensions equal to those of the Princeton and Texas tokamaks. The solutions for a straight coaxial pipe have features that may be related to the rf heating of an overdense plasma. (auth)

20052 (CONF-720705-, pp E6-1-E6-6) VELOCITY DISTRIBUTION OF RF-HEATED ELECTRONS IN A PLASMA AS MEASURED BY FREE–FREE BREMSSTRAHLUNG. Shohet, J. L. (Univ. of Wisconsin, Madison). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

Proceedings of the first topical conference on rf plasma heating.

Radio-frequency heated electrons in a plasma often produce x rays by means of collisions with targets, walls, or free–free electron–ion encounters. Measurement of the intensity of the bremsstrahlung can be used to obtain the electron energy distribution and, in many cases, the anisotropy of the plasma. A more sensitive technique, eliminating several ambiguities, utilizes the polarization of the bremsstrahlung by means of Compton scattering. Both experimental measurements and theoretical calculations show that this technique can be very helpful in determinations of the velocity distribution of the hot electrons. (auth)

20053 (LA–5250-PR, pp 3-46) THETA-PINCH PROGRAM. Jun 1973.

LASL Controlled Thermonuclear Research Program.

The following topics are discussed: (1) Scyllac 5-m toroidal sector experiment, (2) linear Scyllac, (3) feedback experiments on Scylla IV, (4) Scyllac torus, (5) plasma diagnostics, (6) Scyllac computer and data acquisition, (7) Scyllac feedback system, and (8) electronics development. (MOW)

20054 (MATT-Trans-108) EXPERIMENTS IN CONFINING A PLASMA IN A MULTIMIRROR MAGNETIC TRAP. Budker, G. I.; Danilov, V. V.; Kruglyakov, E. P.; Ryutov, D. D.; Shun'ko, E. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1973. Translation of IYAF–22-73. 32p. Dep. NTIS $3.75.

The experiments were performed in a low-temperature alkaline plasma. A study was made of the density distributions along the trap axis under stationary conditions and also the plasma decay after pulsed disconnection of its source. It turned out that the movement of the plasma along the field is essentially retarded on converting to the multimirror configuration in accordance with the previously published theory. (auth)

20055 CONTAINMENT OF A PLASMA FILAMENT IN A TOKAMAK TO-1 BY AN AUTOMATIC-CONTROL. Artemenkov, L. I.; Kozlov, P. I.; Melikhov, P. I.; Mukhin, P. A.; Papkov, L. N. JETP Lett. (USSR) (Engl. Transl.); 17: No. 5, 179-182(5 Mar 1973).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 17: No. 5, 251-254(5 Mar 1973).

The main discharge characteristics were investigated experimentally in a TO-1 Tokamak without a jacket, in which the plasma filament was kept in equilibrium by an automatic-control system. Three stages of discharge were observed: macroscopically unstable, "free" motion, and contact with the diaphragm. The discharge duration and the energy content of the plasma increase with increasing equivalent time constant of the control winding. (auth)

20056 INFLUENCE OF SATURATION EFFECTS ON STIMULATING SCATTERING IN LASER HEATING OF A PLASMA. Vinogradov, A. V.; Zel'dovich, B. Ya.; Sobel'man, I. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 17: No. 5, 195-198(5 Mar 1973).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 17: No. 5, 271-274(5 Mar 1973).

The reflection of powerful laser radiation from a plasma produced when laser pulses are focused on a solid target is considered. It is shown that to calculate the reflection coefficient correctly it is necessary to take the nonlinear effects into account. In particular, saturation effects limit the reflection as a result of stimulated Thomson scattering and stimulating scattering by ions at the 2×10^{11} to 10^{13} W/cm^2 level. (auth)

20057 USE OF STRONG RELATIVISTIC ELECTRON RINGS FOR THE CONFINEMENT OF THERMONUCLEAR PLASMAS. Fleischmann, H. H. (Cornell Univ., Ithaca, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 966-969 (Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Various schemes proposed for the confinement of thermonuclear plasmas are reviewed in which it may be possible to generate and maintain the necessary plasma-internal ring currents by strong self-focused rings of relativistic electrons or protons. Thus, confinement advantages inherent in some of these schemes may become available for an actual fusion reactor. The results of first experiments injecting very-high current beams of relativistic electrons into a magnetic mirror trap show that such electron rings can be generated and give good indications for their stability. (auth)

20058 HIGH-ENERGY ELECTRON COMPONENT OF PLASMA IN TURBULENT HEATING. Matsukawa, Y. (Osaka City Univ.). J. Phys. Soc. Jap.; 34: No. 4, 1066-1072(Apr 1973).

Studies on the temperature measurement of high-energy electrons produced by turbulent heating and by a beam–plasma discharge are presented. High energy electrons consist of at least two components with different effective temperatures in the plasma after turbulent heating by a large current. One of them gives most of the heated pressure but its number is a few percent of all the initial plasma electrons and its temperature nearly corresponds to the discharge voltage. The other has the temperature higher than the former, and its number is much smaller. In a beam–plasma discharge, an electron group with the temperature corresponding to about the accelerating energy of the electron beam is also produced at the beginning of the discharge. A solid-state detector that has high energy resolution to the range of 2 to 5 keV is found to be convenient for x-ray measurement in the beam–plasma discharge. (auth)

Diagnostics

20059 (CONF-720705–, pp C6-1-C6-6) RF SEEDED-PLASMA DIAGNOSTICS. Benns, R. A.; Thompson, S. D.; Williams, J. R.; Clement, J. D. (Georgia Inst. of Tech., Atlanta). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Recent interest in seeded plasmas as working fluids for advanced reactors has created a need for data on plasma properties in the 5000 to 10,000°K temperature range. An rf plasma generator that contains the plasma in a quartz torch lends itself to the optical diagnostic techniques needed to produce data on the heat transfer characteristics of seeded plasmas. The seed vaporizes above 5000°K and the extinction coefficient of hydrogen increases rapidly above 10,000°K. The opacity of the particle-seeded hydrogen is measured by scanning the plasma with a laser beam. The intensity of the beam passing through an optically thick, axisymmetric plasma is measured as a function of position and related to the opacity as a function of radius by an Abel Inversion technique. (auth)

20060 (N-73-18733) DOUBLE ELECTROSTATIC PROBE FOR MEASURING DENSITY, TEMPERATURE, AND VELOCITY OF A FLOWING PLASMA. Chubb, D. L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1973. 22p. (NASA-TN-D-7223). NTIS.

A method for obtaining plasma electron temperature and density, as well as the Mach number and flow velocity from the current–voltage characteristic of a flat-faced double probe, is presented. Calculated momentum fluxes of a flowing argon plasma obtained with this probe are compared with experimentally determined momentum fluxes. Reasonable agreement is obtained. (auth)

20061 (NP-19826) ONE POSSIBILITY OF MULTIFRAME HOLOGRAPHING OF MICROSECOND PROCESSES WITH SYNCHRONIZATION BY SIGNALS FROM INVESTIGATED PROCESSES. Smirnov, A. G.; Smirnov, V. G.; Stasel'ko, D. I. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1972. 9p. (In Russian). Dep. NTIS (U.S. Sales Only) $3.00.

A holographic device for multiframe holographing of microsecond processes in a thermonuclear plasma is described. The spatial–temporal separation of coherent light beams necessary for the registration of individual-frames holograms are made by separation of the active laser element by a screen having holes and a traveling-wave slit formed in an acoustic-optical shutter. (auth)

20062 CONDUCTIVITY MEASUREMENTS IN WEAK PLASMA BY rf PROBE. Coghe, A.; Vulpetti, G. Termotecnica (Milan); 27: No. 5, 275-278(May 1973). (In Italian).

The characteristics of using a rf probe for conductivity measurements in H_2/air and C_2H_2/air flames with NaCl seeding are described. (MOW)

20063 BASIC METHOD FOR REALIZATION OF TEMPERATURE SCALE AT 10^4K BY PHOTOMETRIC COMPARISON BETWEEN VACUUM-UV-BLACKBODY RADIATION OF A PLASMA AND SYNCHROTRON RADIATION. Stuck, D.; Wende, B. (Physikalisch Technische Bundesanstalt, Brunswick). pp 105-117 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 1. Preston-Thomas, H. (ed.). Pittsburgh; Instrument Society of America (1972).

From 5th symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P1).

For realization of a temperature scale by radiation measurements in the region of 10^4K, plasma blackbody radiation was produced in order to extend the conventional pyrometric method to plasma temperatures. To overcome the weak temperature dependence of the blackbody radiation at 10^4K in the visible range, radiation was measured in the vacuum-uv spectral range. The plasma source was a wall-stabilized argon arc plasma (pressure: 10^5 N m^{-2} $\hat{=}$ ≈1 atm) to which a small amount of hydrogen and carbon dioxide had been added. The windowless connection between the plasma and the vacuum monochromator was affected by a differential pumping system consisting of five stages (total length: 40 mm). A pressure difference between 10^5 N m^{-2} (= ≈1 atm, plasma) and 10^{-3} N m^{-2} (= ≈10^{-5} torr, vuv monochromator) could be obtained. Thus, blackbody radiation of Ly α and several Cl spectral lines in the range of 120 to 170 nm can be observed. The plasma vacuum-uv radiance cannot be measured against the radiance of a conventional blackbody radiator because, even at 3000 K, its radiance at 100 nm is not measurable. Therefore, gas-discharge lamps were calibrated by means of calculable standard radiation of a 6-GeV electron synchrotron (DESY in Hamburg). Then plasma blackbody radiation was measured by a photometric comparison between these secondary standard lamps and the plasma. The method is discussed with respect to the radiative transitions between the ground level and the first excited level of carbon atoms (Cl-multiplet $2s^22p^2\ ^3p - 3s^3p^o$: λ = 165.63; 165.69; 165.70; 165.74; 165.79; and 165.81 nm). At present, the estimated error of the radiation measurements for these transitions is $\Delta L_\lambda/L_\lambda = \pm 0.075$ producing an error of temperature of $\Delta T/T = \pm 8 \times 10^{-3}$ at 10^4K. Known methods for the determination of plasma temperatures by measurement of radiation emitted from a plasma use the dependencies of line and continuous radiation and line broadening on temperature and particle number densities. The accuracy of these methods is limited by the uncertainties of the various radiation theories, and by the uncertainties of atomic parameters. The method discussed is free of these disadvantages and therefore may be considered as a basic method for the realization of a temperature scale in the range of plasma temperatures. (auth)

20064 MEASUREMENTS ON LASER-PRODUCED PLASMAS FROM LITHIUM TARGETS USING A RETARDING POTENTIAL PROBE. Matoba, T. (Kyoto Univ.). Jap. J. Appl. Phys.; 11: No. 5, 770-771(May 1972).

The experimental results clearly show that the ion energies suffer a little change with the laser power, and the number of ions is nearly proportional to the laser power. (MOW)

20065 POSITIVE ION SHEATH OF A PLANE PROBE IMMERSED IN A PLASMA. Sen, C.; Basu, J. (Saha Inst. of Nuclear Physics, Calcutta). Jap. J. Appl. Phys.; 11: No. 1, 113-114 (Jan 1972).

It is customary, from the experimental point of view, to define the extent of the sheath by extrapolating the linear portion of the electric field near the probe; the potential profile in the sheath is evidently taken to be parabolic in nature in this approximation. The approximation has also been used for carrying out theoretical investigations on the rf properties of the sheath. The authors examine, in this note, the validity of the approximation particularly with a view to obtaining a simple, though approximate, relation between the probe potential and the sheath thickness. (MOW)

20066 CHARACTERISTICS OF THE INTERNAL POSITIVE COLUMN OF A HOLLOW CATHODE DISCHARGE DEDUCED FROM PROBE MEASUREMENTS. Brunet, A. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). Compt. Rend., Ser. A, B; 276: No. 21, 813-816(21 May 1973). (In French).

An electrostatic probe was introduced into the cathode of a hollow-cathode discharge. In spite of the limited exploration possibilities, the electron density and the plasma potential were determined for both ends of the internal positive column. If, in addition, the pressure distribution is taken into consideration, it is possible to determine the order of magnitude of the characteristic parameters of the ionization. (FR)

Kinetics (General)

20067 (AD-758357) CORONAL EQUILIBRIUM OF HIGH-ATOMIC-NUMBER PLASMAS. Final Report. Mosher, D. (Naval Research Lab., Washington, D. C.). Mar 1973. 28p. (NRL-MR-2563). NTIS.

The distribution of ionization states in carbon, aluminum, copper, and tungsten plasmas is determined from the corona model equilibrium. The variation of mean ionization level, internal energy, and radiation rates with temperature is then determined by averaging over the ionization states. Results are presented in a form that allows the reader to easily use them with plasma fluid equations in order to describe the dynamics of radiation from high atomic plasmas. (auth)

20068 (CONF-720705–, pp C5-1-C5-7) ELECTROMAGNETIC FIELDS IN ELECTRODELESS DISCHARGES OF ARBITRARY LENGTH. Medgyesi-Mitschang, L. N.; Mullen, J. H. (McDonnell Douglas Corp., St. Louis). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Closed-form solutions were obtained for the EM fields in cylindrical rf discharges of finite length, having a uniform electron density (N_e) throughout, a radial parbolic N_e variation or an axial cosine variation. The solutions obtained represent a generalization of previously published solutions for the uniform and radially varying cases. Specific calculations made for a variety of plasma conditions and discharge dimensions, showed that the end effects

can have significant effect on the EM field intensities in the central portion of a rf discharge. (auth)

20069 (CONF-720705–, pp D4-1-D4-7) ELECTRON-BEAM EXCITATION OF FINITE-SIZED PLASMA NEAR THE LOWER HYBRID FREQUENCY. Bhatnagar, V. P. (Ecole Royale Militaire, Brussels); Colestock, P. L.; Getty, W. D. Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Published experimental results have shown that a modulated electron beam can excite geometrical resonances of a plasma column through which it passes. These geometrical resonances occur above the ion-plasma frequency, and can be predicted by the quasi-static analysis of a finite-length, finite-diameter beam–plasma system. The analysis is extended to cover the lower-hybrid frequency range for a uniform beam–plasma system and to include the effect of nonuniform plasma density. Dispersion equations are used to find the complex propagation constants as functions of frequency. The waves are superimposed subject to axial boundary conditions and the resulting total fields are calculated. (auth)

20070 (FRNC-TH-375) STUDY OF ELECTRON-ION RECOMBINATION MECHANISM IN THE VAPOR OF IONIZED Cs. Saint-Hilaire, G. (Paris Univ., Orsay (France)). 1972. 110p. (In French). Dep. NTIS (U. S. Sales Only) $7.50.

Thesis.

The evolution during the afterglow period of a Cs plasma was studied for pressures between 2×10^{-2} and 4 torr. A microwave heating system which enables direct measurements to be made of the dependence of the overall recombination coefficient on the electronic temperature was studied. It is demonstrated that the collisional and radiative recombination mechanism is predominant at the beginning of the afterglow but that a number of mechanisms (possibly conversion reactions) then determine the evolution of the plasma, the effect occurring more and more precociously with higher plasma pressures. The efficiency of this mechanism varies approximately with the square root of the pressure. Research undertaken with a microwave heating device operating at different pressures and at an electronic density of 2×10^{11} cm^{-3} (for which the contribution of the radiative and collisional recombination is very small) enabled the dependance of the efficiency on $T_e^{-\frac{1}{2}}$ to be established. (FR)

20071 (N–73-18724) FORMATION OF ION ACOUSTIC SHOCKS. White, R. B.; Fried, B. D.; Coroniti, F. V. (California Univ., Los Angeles. Plasma Physics Group). Jan 1973. Contract N00014-69-A-0200-4023. 19p. (NASA-CR–130994; PPG–142). NTIS.

Recent experiments performed in the double plasma (DP) device have verified the existence of electrostatic ion acoustic laminar shocks. The influence of the piston on the shock structure is investigated by modeling the DP device and by numerically solving the temporal and spatial evolution of the shock. In order to isolate piston effects, as opposed to kinetic theory effects such as reflected ions and trapped electrons, the DP plasma is modeled as a cold ion fluid with isothermal Boltzmann electrons. It is shown that laminar shock transitions with structure agreeing with DP shock experiments can be excited. (auth)

20072 RADIATION RESISTANCE OF A DIPOLE IN A DRIFTING MAGNETOPLASMA. Singh, N. (Indian Inst. of Tech., Kanpur, India). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-21: No. 3, 399-405(May 1973).

The radiation resistance R of a short electric dipole in a drifting magnetoplasma is calculated. For very small length, R is found to behave as V_0^{-3} where V_0 is the drift velocity along the magnetostatic field. (auth)

20073 EFFECT OF ELECTROSTATIC AND VIRIAL CORRECTIONS ON THE COMPRESSIBILITY FACTOR OF A NITROGEN PLASMA ($T < 20000$ K and $10 < p < 10000$ atm.). Fenech, C.; Fauchais, P. (Limoges Univ., France). Compt. Rend., Ser. A, B; 276: No. 18, 721-724(2 May 1973). (In French).

Studies of the compressibility factor $Z = pV/RT$ of nitrogen demonstrated that for $T > 8000$ K and $p < 500$ atmosphere, only Debye-type electrostatic corrections are significant. (FR)

Kinetics (Experimental)

20074 (AD-758880) MAGNETIC FIELD ANNIHILATION OF IMPULSIVE CURRENT SHEETS. Interim Scientific Progress Report. Dailey, L.; Davis, H. A.; Loyberg, R. H. (TRW Systems Group, Redondo Beach, Calif.). 31 Mar 1973. Contract F44620-71-C-0031. 56p. (AFOSR-TR-73-564). NTIS.

An impulsive plasma accelerator employing two, closely spaced, flat, spiral, coils was used to study plasma acceleration by magnetic field annihilation. Measurements of plasma current density and electric and magnetic field were made with miniature probes. Spectral measurements were made with a monochromater. Electron temperature and density were measured by line intensities and Stark broadening. There is good agreement between measured and calculated conductivity. Radial velocity measured by Doppler shift showed values produced by field annihilation were three times greater than the axial velocities prior to current-sheet collision. A few percent of the capacitor bank energy was converted to radial ion kinetic energy. (MOW)

20075 EXPERIMENTAL STUDY OF A CONICAL THETA-PINCH PLASMA GUN. Hirano, K.; Kondo, Y.; Shimoda, K. (Gunma Univ., Kiryu, Japan). Jap. J. Appl. Phys.; 12: No. 2, 270-276(Feb 1973).

Properties of plasma produced with a conical theta-pinch gun are described. Streak photography, the magnetic probe method, and laser interferometry are used for the measurement of the plasma. When the coil current is crowbarred, a single pulsed helium plasma is produced with the following characteristics: velocity of 1 to 5 cm/μsec, radially averaged electron density of 0.4 to 4×10^{16}/cm^3 and electron temperature of 5 to 6×10^4 K. The length of the plasma is shortened by the diversion of the coil current. The gun system has the multipole windings to isolate the plasma from the wall of the conical discharge chamber. Impurities in the plasma are examined using the spectral line from silica ions, and the effect of the multipole field is not noticeable for the impurity reduction. (auth)

Kinetics (Theoretical)

20076 (AD–758275) DIRECTIONAL TRANSPORT EQUATIONS FOR PLASMAS. Wang, P. K. C. (California Univ., Los Angeles. School of Engineering and Applied Science). Feb 1973. 17p. (UCLA-ENG–7325; AFOSR-TR–73-515). NTIS.

The equations governing the directional transport of plasmas are derived from the Boltzmann's equation by averaging over a given subset of the velocity space. Their application to plasma confinement by means of external time-dependent electromagnetic fields is discussed. (auth)

20077 (AD–758689) RADIATIVE TRANSFER UNDER NON-LOCAL THERMODYNAMIC EQUILIBRIUM CONDITIONS. Volume III. Physics of a Nonequilibrium Plasma. Final Report. Vulliet, W. G.; Delmer, T. N.; Woods, A. J. (Gulf Radiation Technology, San Diego, Calif.). 25 Feb 1971. Contract DASA01-70-C-0079. 104p. (GULF-RT-11023; DNA-2963-F-3). NTIS.

The physics necessary to treat the time evolution of a finite plasma under the influence of a radiation field is discussed. The atomic physics includes radiative transition rates for hydrogenic ions and approximations to the collision rates for such ions. An approximate treatment of line radiation makes calculations for finite systems feasible. A model for nonhydrogenic ions is given that requires a minimal tabulation of atomic data but retains essential properties of such ions. The methods are applied to a planetary nebula and are shown to give reasonable results. (auth)

20078 (CONF-730710–) PROCEEDINGS OF THE SIXTH CONFERENCE ON NUMERICAL SIMULATION OF PLASMAS, LAWRENCE BERKELEY LABORATORY, UNIVERSITY OF CALIFORNIA/BERKELEY, CALIFORNIA, JULY 16–18, 1973. (California Univ., Livermore. Lawrence Livermore Lab.). 1973. Contract W7405-eng-48. 89p. Dep. NTIS $5.45.

A total of 40 papers are included. The papers are divided into sessions as follows: (1) methods, (2) electromagnetic codes, and (3) fluids and magnetohydrodynamics. (MOW)

20079 APPLICATION OF THE HYDROMAGNETIC ENERGY PRINCIPLE TO A PLASMA BETWEEN ELECTRODES. Seymour, P. W.; James, M. K. (Univ. of Adelaide). Aust. J. Phys.; 26: No. 2, 123-134(Apr 1973).

The approach of Van Kampen and Felderhof (1967) is extended to derive the variation of potential energy δW for a finite magnetized plasma contained by a vacuum magnetic field and in contact with conducting electrodes supported by insulators. The method gives a result in agreement with that of Bernstein et al. (1958) except for modification of the vacuum contribution. It leads to proof that the usual interpretation of the surface contribution to δW incorrect because of modification of the vacuum magnetic field energy associated with second-order distortion of the plasma boundary surface. (auth)

20080 TRANSPORT OF URANIUM FREE PARTICLES IN A DC ARC PLASMA BURNING IN AIR AT ATMOSPHERIC PRESSURE. Avni, R.; Goldbart, Z. (Israel Atomic Energy Commission, Negev). Spectrochim. Acta, Part B; 28: No. 7, 241-252 (Jul 1973).

The transport parameter ψ was calculated for the free particles of uranium in a dc arc plasma burning in air. Using the "wire method," the volatilization rate (Q_w), the total concentration of free particles (n_t), the axial velocity (v_l) of uranium particles, and the plasma cross section (S) were measured. The transport parameter was calculated for cylindrical symmetry of the arc. The total particle concentration calculated by the wire method was compared to values obtained by absolute intensity measurements of ion and atom spectral lines of uranium. This led to an estimate of the molecular concentration of uranium in the dc arc plasma. (auth)

20081 EFFICIENT INJECTION OF HIGH MICROWAVE POWERS INTO THE OVERDENSE MAGNETOACTIVE PLASMA IN A WAVEGUIDE. Musil, J. (Inst. of Plasma Physics, Prague); Zacek, F.; Budnikov, V. N. Czech. J. Phys.; 23: No. 7, 736-741 (1973).

On the boundary vacuum of a dense magnetoactive plasma, an incident RHCP (right hand circularly polarized) wave is strongly reflected if $\omega_0^2/\omega^2 \gg 1$ and $\omega_{ce}/\omega > 1$; ω, ω_0, ω_{ce} are the incident wave frequency, the plasma frequency, and the electron cyclotron frequency, respectively. This reflection strongly lowers the efficiency of the plasma heating by microwaves. The experimental study shows that a suitable matching system consisting of dielectric plates, placed in front of the plasma, can ensure practically complete transfer of the RHCP wave energy into a dense plasma. The experiment was carried out in the S band waveguide (λ = 12.7 cm) with the power of the order of 1 kW. (auth)

Production

20082 (AD-757043) PRODUCTION OF THERMONUCLEAR PLASMAS BY ANOMALOUS DIFFUSION OF MAGNETIC FIELDS IN A HIGH VOLTAGE THETA PINCH. Annual Summary Report. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Nov 1972. Contract N00014-67-A-0239-0015. 52p. NTIS.

The report summarizes work done at the University of Maryland on the problem of plasma heating by application of a large amplitude magnetic pulse to the plasma boundary. Particular interest is given to understanding the ion heating that results from growth of drift instabilities. In the period covered by the report the experimental work has concentrated on parametric studies of ion heating for various initial conditions, and on measurements of density fluctuations by light scattering. The theory concentrated on finding realistic models for resistive and viscous loss to be used in numerical fluid codes. (MOW)

20083 (AD-757247) INVESTIGATION OF SELF-GENERATED MAGNETIC FIELDS ASSOCIATED WITH A LASER-PRODUCED PLASMA. McKee, Leslie Lawrence III (Naval Postgraduate School, Monterey, Calif.). Dec 1972. 172p. NTIS.

Thesis.

A plasma was produced by irradiating a 5-mil-thick Mylar foil with a 300-MW, 25-nsec Nd laser pulse. Magnetic fields were observed to spontaneously arise when the laser-produced plasma was formed. The dependence of the selfgenerated magnetic fields on position, time, incident laser power, and ambient background pressure was investigated. The strength of the magnetic field, as well as its spatial and temporal dependences, was found to depend quite strongly on the background pressure of nitrogen. Most significantly, the strength of the field increased by a factor of six when the pressure of the nitrogen background was increased from 1 mtorr to 200 mtorr. The results are analyzed by use of a theory in which the presence of a background gas influences the generating mechanism of the fields. (auth)

20084 (AD-757790) TWO-STREAM COUPLING OF CORONA AND CORE IN LASER-HEATED PELLETS. O'Neil, T. M.; Rosenbluth, M. N. (Institute for Defense Analyses, Arlington, VA. Jason Div.). Jul 1972. Contract DAHC15-67-C-0011. 24p. (IDA-HQ-72-14450). NTIS.

When a pellet is heated by CO_2 laser, the tenuous plasma corona in which the light is absorbed quickly becomes collisionless. This poses a problem for CTR schemes which rely on the heated corona to compress the inner solid core of the pellet. As a replacement for collisional coupling between corona and core, the present report considers a turbulent coupling which develops from a two-stream instability between the heated corona electrons and the cold core electrons. Preliminary results indicate that the coupling is only marginally effective, unless the laser light is amplitude modulated so the heating occurs in short bursts. (auth)

20085 (IPP-IV-46) EVIDENCE OF STIMULATED BACK-SCATTERING OF LASER RADIATION FROM A LASER PRODUCED PLASMA. Eidmann, K.; Sigel, R. (Max Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Dec 1972. 22p. (CONF-721099-2). Dep. NTIS (U.S. Sales Only) $3.25.

From European laser-fusion conference; Marly le Roi, France (9 Oct 1972).

The reflection of laser light from a laser-produced deuterium plasma was experimentally investigated. Strong evidence of stimulated backscattering was obtained. (auth)

20086 (LA-DC-72-1113) U. S. AEC LASER-FUSION PROGRAM. Boyer, K. (Los Alamos Scientific Lab., N. Mex.). 1972. 14p. (CONF-721099-2). Dep. NTIS $3.00.

From European laser-fusion conference; Marly le Roi, France (9 Oct 1972).

The AEC laser-fusion program is conducted primarily at the Los Alamos Scientific Laboratory of the University of California and the Lawrence Livermore Laboratory. The program consists of work in four major areas: pellet design and burn calculations and experiments, laser–matter interactions theory and experiments, laser development, and application studies. The basic technique considered here is to use the laser energy to compress and heat the pellet in a symmetrical fashion to achieve burning conditions. Such calculations indicate the ratio of thermonuclear energy to laser energy might be 70 to one for a fairly optimum case assuming that compressions of several thousand-fold might be achieved. These calculations predict a coupling efficiency of laser energy to the fuel proper of 10%. A review of the program is presented. (MOW)

20087 (UCRL-74815) PROBLEMS OF THE LASER-AUGMENTED PINCH PROPOSAL. Shearer, J. W. (California Univ., Livermore. Lawrence Livermore Lab.). 18 Jun 1973. 4p. (CONF-730705-11). Dep. NTIS $3.00.

From sixth European conference on controlled fusion and plasma physics; Moscow, USSR (30 Jul 1973).

Further evaluation of the laser-augmented pinch concept (UCRL-74628) shows serious problems: A DT plasma, compressed to a density of $\sim 10^{20}$ with heating to 10 keV, must, according to the Lawson criterion, be contained for $\tau \geq 10^{-6}$ s. Magnetic field containment of the plasma pressure of ~3 Mbar requires a field of ~9 MG. For a small growth rate of the M = 1 instability compared to $1/\tau$, a large average pinch density $\rho \gg 10^5\ R_p^2\ g/cm^3$ (R_p = total plasma radius) is required. The size of the electrical power supplies necessary to achieve the Lawson criterion with such dense sheaths is very large (hundreds of MJ/m). (DLC)

20088 LASER INDUCED PLASMA: PROGRESS WITH THE BACK-REFLECTION PROBLEM. Hughes, J. L.; Hollis, M. J. (Australian National Univ., Canberra). Search; 4: No. 4, 117-118(Apr 1973).

An apparatus required to stop "back reflection" in laser production of plasma was successfully tested using a 250-μ-dia tungsten wire target. Initial tests of the Nd^{3+}/glass system used degraded output to avoid the possibility of damage, but it is expected that the peak power levels necessary for self-sustaining thermonuclear reactions can now be achieved with "back reflection" suppressed. (AT)

20089 AVERAGED EQUATIONS OF LASER IMPLOSIVE-COMPRESSION OF D–T PLASMA WITH ABLATION OF HEAVY ENVELOPE, FUSION HEAT BEING TAKEN INTO CONSIDERATION. Kaliski, S. (Inst. of Fundamental Technological Research, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 21: No. 4, 35-44 (1973).

Based on the integral similarity model, equations are derived for laser, concentric compression of D–T plasma through an implosion of a heavy envelope heated by a laser beam. For the study of the D–T ball, the model of a Fermi liquid with perturbed temperature is taken, and for the envelope, the model of two-temperature perfect gas. The method of laser compression of plasma constitutes an important step towards realization of micro-fusion. It permits lowering of the critical value of laser pulse energy below those hitherto known. The assumptions of the system and of the D–T ball and envelope models are discussed. A complete system of equations of the problem with limiting conditions is derived. (auth)

20090 ION TEMPERATURE OF LASER-PRODUCED PLASMA. Kang, H. (Nagoya Univ., Japan); Yamanaka, T.; Yoshida, K.; Waki, M.; Yamanaka, C. Jap. J. Appl. Phys.; 11: No. 5, 765-766 (May 1972).

Ion temperatures in laser-produced plasma have not been reported so much, in contrast with many results on electron temperatures. The authors of this note estimated ion temperatures of laser-produced plasma from ion velocity distributions measured by a time-of-flight experiment. (MOW)

20091 PROPERTIES OF PLASMA PRODUCED BY HIGH-POWER LASER. Waki, M. (Osaka Univ.); Yamanaka, T.; Yoshida, K.; Kang, H. B.; Yamanaka, C. Jap. J. Appl. Phys.; 11: No. 3, 420-421(Mar 1972).

The process of plasma formation by high-power laser beam

has been investigated theoretically by several authors. The relation between electron temperature and laser power was studied experimentally by Floux and Fauquignon and Sigel and Witkowski using 30-nsec laser pulses. To clarify the mechanisms of plasma heating, the authors of this note measured electron temperature and reflectivity of the plasma produced by 2.3- to 10-nsec laser pulses and found an oscillation of reflectivity, which seems to be caused by the ion-acoustic wave. (MOW)

20092 LASER PRODUCED PLASMAS AND FUSION. Ramsden, S. A. (Univ. of Hull, Eng.). (1972). vp.

From 2nd general conference of the European Physical Society; Wiesbaden, Germany (3 Oct 1972).

Review is given of conditions required to achieve thermonuclear fusion with lasers, the experimental progress made since 1968 in producing neutrons from D_2-pellets with Nd glass lasers, theoretical work, (including observed nonlinear effects), reactor concepts, and CO_2-laser heating and compression. (GE)

20093 MULTI-AMPERE DUOPIGATRON ION SOURCE. Morgan, O. B. Jr. (To United States Atomic Energy Commission). U. S. Patent 3,740,554. 19 Jun 1973. Filed Date 13 Apr 1972. 6p.

A duoplasmatron ion source is modified to provide a large plasma surface with a uniform density at a target cathode. The target cathode and the acceleration and deceleration electrodes are gridded or multi-apertured and are spaced in close proximity each to the others with the apertures being in alignment. With such an arrangement, it is possible to extract multi-ampere bright ion beams at energies of tens of keV. Conversion of the ion beam to a neutral-particle beam can be readily accomplished by addition of a gas cell. (Official Gazette)

20094 HIGH-ENERGY NEUTRAL-PARTICLE BEAM SOURCE. Damm, C. C.; Osher, J. E.; Post, R. F. (To United States Atomic Energy Commission). U. S. Patent 3,742,219. 26 Jun 1973. Filed Date 23 Jun 1971. 8p.

An ion source directs a beam of low-energy positive ions through a first gas charge exchange cell forming a beam of neutral particles with some negative ions therein. The neutral particle component of the beam is then directed through an aligned series of similar charge-exchange cells in each of which some of the neutral particles are converted into negative ions. A magnetic field is applied to the mixed-particle beam emerging from each cell to deflect the negative ions so as to converge to form a common negative ion beam which is passed through a charged-particle accelerator to yield a high-energy negative ion beam then through a gas cell to strip electron therefrom forming a high-energy neutral particle beam which may then be directed into the magnetic containment zone of a controlled fusion reactor to be ionized and trapped to form a plasma. (Official Gazette)

Stability

20095 (AD-758809) BOUNCE: USER'S MANUAL. Technical Report, January-October 1972. Godfrey, B. B.; Rhoades, C. E. Jr.; Taggert, K. A. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Mar 1973. 128p. (AFWL-TR-72-232). NTIS.

The report is intended primarily as a user's manual for the optimized one-dimensional, nonrelativistic electrostatic particle code BOUNCE. This code is particularly well suited for the investigation of nonlinear, laser-induced instabilities in a one-dimensional homogeneous plasma, but is useful for other simulations as well. A brief discussion of numerical techniques is included. Complete FORTRAN and CDC 6600 compass assembly language listings together with sample output are attached. (auth)

20096 (LA-5250-PR, pp 84-100) THEORETICAL PHYSICS PROGRAM. Jun 1973.

LASL Controlled Thermonuclear Research Program.

Summaries of theoretical work are given for the following programs: (1) Scyllac, (2) theta pinch, (3) profile-tailored toroidal Z pinch, and (4) magnetic-implosion-heating projects. Special emphasis was placed on the study of plasma equilibrium and stability in complicated toroidal configurations, using MHD or Vlasov models. (MOW)

20097 (UCID-16293) UNFINISHED THEORETICAL PROBLEMS IN MIRROR RESEARCH. Berk, H. L. (California Univ., Livermore. Lawrence Livermore Lab). 21 May 1973. Contract W-7405-eng-48. 31p. Dep. NTIS $3.75.

The instability theory for the 2X-II and Baseball experiments is discussed in terms of areas needing further work. The J surfaces near the mirror throat of Baseball are discussed. The discrepancies in theoretical and experimental research dealing with decay times in mirror machines are described. (MOW)

20098 EQUILIBRIUM AND STABILITY OF A CURRENT-CARRYING PLASMA. Nagao, S. Technol. Rep. Tohoku Univ.; 35: No. 1, 45-54(1970).

The state of a current-carrying cylindrical plasma is investigated when the total current in the plasma and the externally applied magnetic field vary sinusoidally, in particular the effects due to a finite plasma conductivity. Stability considerations are based on the shear and minimum-B properties of the stationary solutions. Applications to actual Tokamak and θ-pinch plasmas are discussed. (App. Mech. Rev.)

20099 INTRODUCTION INTO PLASMA PHYSICS. II. Waves and Instabilities. Cap, F. Berlin; Akademie-Verlag GmbH (1972). 211p. (In German). $3.00.

The problem of plasma containment is considered, giving attention to the use of magnetohydrostatic fields and closed magnetic configurations for containing the plasma. Causes of MHD instability are discussed together with the characteristics of instability occurrence in ideal MHD, real MHD, and inhomogeneous plasma. EM waves in plasma and aspects of the occurrence of microinstabilities are also examined, taking into account various theories, waves in isotropic and anisotropic cold plasma, waves in isotropic and anisotropic warm plasma, waves in isotropic and anisotropic Vlasov plasma, the Penrose criterion, beam instabilities, and instabilities due to deviations from the Maxwell distribution. (IAA)

20100 PLASMA CONTROL BY FEEDBACK. Hendel, H. W.; Chen, F. F.; Chu, T. K.; Furth, H. P.; Perkins, F. W.; Simonen, T. C.; Taylor, J. B. (To United States Atomic Energy Commission). U. S. Patent 3,733,248. 15 May 1973. Filed Date 15 Feb 1972. 14p.

Method and apparatus are described for controlling instabilities in a magnetically confined plasma by applying feedback to the particle density, momentum, energy, and/or potential of the plasma, for maximizing the density of the same and/or for providing means for confining the plasma for long periods of time and/or at high temperatures. More particularly, this invention contemplates feedback control of the plasma by selectively injecting particles, momentum or energy into the plasma. In another aspect, this invention contemplates feedback control of the magnetic confining field. (auth)

Thermonuclear Engineering and Equipment

Refer also to abstracts 18096 and 19096.

20101 (BNWL-B-283) THERMAL HYDRAULIC ANALYSIS OF THE PACIFIC NORTHWEST LABORATORY FUSION-FISSION HYBRID REACTOR CONCEPT. Sutey, A. M.; Stewart, C. W. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1973. Contract AT(45-1)-1830. 35p. Dep. NTIS $3.75.

A preliminary thermal hydraulic analysis was performed on a helium-cooled subcritical blanket of a fusion-fission reactor concept having an overall power level of 0.75 MW/m^3. Three candidate fuel rod materials, metallic uranium, uranium carbide and uranium oxide, were considered. Helium coolant operating conditions considered were similar to those typical of an HTGR. Both steady-state and pulsed power modes of operation were studied. (auth)

20102 (IAE-2180) STUDY OF THE STRUCTURE OF A THERMONUCLEAR COMBUSTION WAVE IN A LAYER OF PLASMA BEING CONTAINED BY MATERIAL WALLS. Nastoyashchii, A. F.; Shevchenko, L. P. (Institut Atomnoi Energii, Moscow (USSR)). 1972. 16p. (In Russian). Dep. NTIS (U.S. Sales Only) $3.00.

20103 (JUL-927-PP) FORCES AND MOMENTS IN ARBITRARY TOROIDAL MAGNETIC FIELD COILS SUBJECTED TO ARBITRARY EXTERNAL FORCES. Zabka, W. (Kernforschungsanlage, Juelich (West Germany)). Feb 1973. 53p. (In German). Dep. NTIS (U.S. Sales Only) $4.75.

The computation of axial forces, bending moments, and torsion moments in arbitrary toroidal-magnetic-field coils with variable cross section subjected to arbitrary external forces is described. The deflection of the coil and the influence of additional supports of the coil on forces and moments are computed. For a special coil configuration subjected to a special distribution of external forces the results of a numerical computation are discussed. (auth)

20104 (LA-5250-PR) LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM. Progress Report for a 12-Month Period Ending December 1972. Ribe, F. L. (comp.). (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 135p. Dep. NTIS $5.45.

Separate abstracts were prepared for six of the included sections. (MOW)

For abstracts of individual sections see: 20053, 20096, 20105–20107, and 20123.

20105 (LA–5250-PR, pp 47-64) Z-PINCH PROGRAM. Jun 1973.

LASL Controlled Thermonuclear Research Program.

Research progress on the following topics is described: (1) shock-heated toroidal z-pinch, (2) MHD stability analysis, (3) CO_2 holography, (4) transfer capacitor circuit, (5) detonator crowbar switch, and (6) all-metal toroidal discharge tube. (MOW)

20106 (LA–5250-PR, pp 73-83) IMPLOSION-HEATING EXPERIMENT. Hammel, J. E.; Henins, I.; Marshall, J.; Sherwood, A. R. Jun 1973.

LASL Controlled Thermonuclear Research Program.

Brief discussions are given for the following topics: (1) preionization, (2) pulse generator systems, (3) diagnostics, (4) chronology, and (5) high-voltage technology. (MOW)

20107 (LA–5250-PR, pp 107-123) FUSION TECHNOLOGY. Jun 1973.

LASL Controlled Thermonuclear Research Program.

A brief discussion of progress on the Reference Theta-Pinch Reactor is given. Flushing and refuelling the reactor are described along with a neutronic analysis for the core and shielding. (MOW)

20108 (LA-tr–73-32) PROBLEMS OF MEASURING NUCLEAR CONSTANTS FOR THERMONUCLEAR REACTORS. Kuz'min, E. A.; Ogloblin, A. A.; Sidorov, N. I.; Faiziev, A. R. (Institut Atomnoi Energii, Moscow (USSR)). 1972. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., NM) from IAEA Paper SM–170/22. (CONF-730302–14). 37p. Dep. NTIS $4.00.

From symposium on applications of nuclear data in science and technology; Paris, France (12 Mar 1973).

From the available nuclear data it appears that a tritium breeding coefficient greater than unity can be obtained in a thermonuclear reactor using the D–T cycle and with a breeding zone consisting of a mixture of lithium isotopes. However, the present inaccuracies in the nuclear data may considerably influence tritium breeding and the optimum relationship between breeder and construction materials. A fairly extensive program of neutron research in the neutron energy range 7 to 14 MeV is therefore necessary. The main feature of neutron measurements within this range is that there are no monoenergetic neutron sources available. The authors consider the possibility of using normal sources: the reactions D + D, D + T, T + p. Measurement data are presented on the continuous neutron spectrum in the reaction T + p, which limits the use of this reaction as a source of monoenergetic neutrons. Neutron sources based on the use of alpha particles and ^{3}He ions are considered, and currently available sources of continuous-spectrum neutrons are discussed. It is shown that the optimum source of a continuous spectrum of neutrons in the required energy range is deuteron disintegration $E_d \simeq 25$ to 40 MeV. Nuclear constants that can be used in continuous neutron spectrum measurements are considered. (auth)

20109 (LA-UR-73-1053) REVIEW OF SCYLLAC THETA-PINCH EXPERIMENTS. Quinn, W. E.; Ellis, W. R.; Gribble, R. F.; Harder, C. R.; Kristal, R.; Ribe, F. L.; Sawyer, G. A.; Siemon, R. E.; Thomas, K. S. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 17p. (CONF-730705-12). Dep. NTIS $3.00.

From 6th European conference on controlled fusion and plasma physics; Moscow, USSR (30 Jul 1973).

Scyllac research on 5- and 8-m toroidal sectors, and the 5-m linear theta pinch are discussed. In addition, plans for the full Scyllac torus, feedback stabilization, and a staged theta pinch are outlined. (auth)

20110 (ORNL-TM–4277) COUPLED NEUTRON AND GAMMA-RAY CROSS SECTION SETS FOR FUSION REACTOR CALCULATIONS. Kriese, J. T. (Oak Ridge National Lab., Tenn.). Aug 1973. Contract W-7405-eng-26. 9p. Dep. NTIS $3.00.

Coupled seventy-three energy-group P_3 neutron and gamma-ray cross section sets have been developed for calculating fluxes in conceptual fusion reactor designs. These cross section sets are suitable for use with either the discrete ordinates code ANISN or the Monte Carlo code MORSE. (MOW)

20111 MEDIUM-BETA TORUS JFT-2 FOR NUCLEAR FUSION RESEARCH. Kazawa, Y.; Hashimoto, H.; Wase, K. (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 55: No. 2, 107-113(Feb 1973). (In Japanese).

The JFT-2 equipment will play a vital role in the research in nuclear fusion which is being pushed forward as one of the most important national projects. The new equipment far excels the older types not only in capacity but in characteristics. An outline and technical problems involved are given. (auth)

20112 EFFECTS OF MULTIPOLE CUSP FIELD TO THE INITIAL PLASMA OF THETA PINCH. Nogi, Y.; Miyamoto, T. (Nihon Univ., Tokyo). J. Phys. Soc. Jap.; 34: No. 4, 1059-1065 (Apr 1973).

It is shown that the initial current of a theta pinch can be separated from the discharge tube wall by the multipole cusp field. The radial distribution of the azimuthal current was measured by several magnetic probes. Under the experimental conditions, the plasma current of the initial phase was clearly separated everywhere from a wall at 20 m torr. The separation was incomplete at higher pressure because of the large reversed field. The average radial magnetic pressure of the multipole field and the condition to separate the plasma current from the tube wall were derived from the simple model that the plasma was the cylindrical column with perfect conductivity. The experimental results agree with the estimation based on this model. (auth)

20113 CLOSED HELIUM-TURBINE CYCLE WITH A FUSION REACTOR. Foerster, S. (Kernforschungsanlage, Juelich, Ger.). Mech. Eng.; 95: No.8, 13-18(Aug 1973).

There are special problems in adapting the helium Brayton cycle as an energy-conversion system for fusion-reactor power plants. But apart from development of the helium heat exchanger inside the fusion reactor, all other cycle components as well as the basic thermodynamic layout are quite similar to those proposed for high-temperature fission reactors with a helium Brayton cycle. At maximum helium temperatures between 850 and 950°C, net plant efficiencies of 40 to 43% are achievable. Design of helium heat exchangers is very sensitive to the choice of layout parameters. (auth)

20114 DEVICE FOR EXPERIMENTS ON HIGH-BETA PLASMAS IN A TOROIDAL GEOMETRY. Mondino, P. L.; Rostagni, G. (Univ., Padua). Alta Freq.; 42: 6-21(Jan 1973). (In Italian).

The main characteristics of a new toroidal machine that makes it possible to perform various classes of experiments on high-beta asymmetrical toroidal plasmas are described. The machine consists of four independent circuits fed by capacitor banks. The total energy of the banks is 120 kJ at the nominal voltage of 40 kV. The results of studies and experiments on various components (capacitors, spark gaps, and transmission lines) are cited, and the design of the coupling transformer between the generators and the utilizer is discussed. The problem of the shielding to reduce the spurious field components is considered on the basis of theoretical and experimental studies on models. (IAA)

20115 STEADY TOKAMAKS WITH RELATIVISTIC ELECTRONS. Ikuta, K. (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 11: No. 11, 1684-1685(Nov 1972).

A simple method of maintaining a toroidal current in resistive plasmas is proposed. A high-current relativistic electron ring with its major radius approximately equal to that of toroidal plasma and a low-intensity ion beam are injected into the plasma. The resultant increase in the plasma current compensates for the decay of the current due to the plasma resistivity. It turns out that the ion beam current required may be much smaller than that of the electron ring. (auth)

20116 MOMENT-FREE TOROIDAL MAGNET DESIGN. File, J.; Mills, R. G.; Sheffield, G. V.; Bonanos, P. (To United States Atomic Energy Commission). U. S. Patent 3,736,539. 29 May 1973. Filed Date 18 Apr 1972. 12p.

Apparatus is described for confining a high-temperature plasma column having a large cross section in a strong magnetic field for increasing the plasma confinement time. The apparatus, comprises a large superconducting moment-free toroidal magnet having coil strands in pure-tension that are self-supported on an inner cylindrical member. In one embodiment, two examples are given for a DT reactor and a catalyzed DD fusion reactor. (auth)

Wave Phenomena

20117 (AD–758316) NOTE ON WAVE–WAVE COUPLING IN NONRESONANT UNSTABLE SYSTEMS. Joackson, E. A.; Raether, M. (Illinois Univ., Urbana. Coordinated Science Lab.). Jan 1973. Contract DAAB07-67-C-0199. 13p. (R–598; UILU-ENG–72-2263). NTIS.

The power series expansion of the dielectric function that is employed in deriving the equations for wave–wave coupling often

diverges if the wave–particle interactions are nonresonant. This difficulty can be eliminated by expanding in terms of the complex eigenmodes of the linear system. These ideas are illustrated for a cold beam–cold plasma system. (auth)

20118 (CONF-720705-, pp A3-1-A3-10) CRITICAL SURVEY OF ION-ACOUSTIC-WAVE EXPERIMENTS AND THEORY. Alexeff, I.; Estabrook, K. (Univ. of Tennessee, Knoxville). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

The object of this paper is to stimulate creative thinking and discussion by pointing out areas where, in the author's opinion, unresolved problems lie. For example, the trapping of electrons in an ion-acoustic wave may not only occasionally happen, but is apparently required for undamped wave propagation. The generation of ion-acoustic waves by gridded electrodes in plasmas not only always is accompanied by streaming solutions (pseudo-waves), but for $\omega > \omega_{pi}$, only streaming solutions are present. Finally, in the Q-machine experiments involving ion-acoustic-wave propagation and Landau damping, the experimental results are recovered by nonlinear computer calculations, even when the computer was instructed to "turn off" the self-consistent electric field in the bulk of the plasma. (auth)

20119 (CONF-720705–, pp B4-1-B4-5) FAST-WAVE PROPAGATION AND DAMPING AT THE SECOND HARMONIC OF THE ION CYCLOTRON FREQUENCY. Cato, J. E. (Texas Tech Univ., Lubbock); Kristiansen, M.; Hagler, M. O.; Watson-Munro, C. N. Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

Proceedings of the first topical conference on rf plasma heating.

Wave damping was predicted and observed to occur for the fast (right-hand polarized) wave at the second harmonic of the ion cyclotron frequency (Ω_i). This damping was observed as the wave propagated into a magnetic beach where $\omega \rightarrow 2\Omega_i$. (auth)

20120 (CONF-720705–, pp D3-1-D3-6) TUNNELING IN THE LINEAR-MODE CONVERSION PROCESS. Moore, B. N.; Oakes, M. E. (Univ. of Texas, Austin). Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

Wave transformation in a magnetized warm plasma slab with a parabolic density profile is examined for the case of two back-to-back lower hybrid conversion layers. By shifting the values of frequency, magnetic field or k_z, the critical layers can be placed close together in the center of the plasma. The outer layers of the plasma sustain both long and a short wavelength propagating modes while the interior is a region of conjugate modes of evanescent character. The connection equations across the two critical layers are developed and used to show that incident long-wavelength energy can tunnel through the center of the plasma into the corresponding mode on the other side. This contributes to the reduction of conversion efficiency as does damping. (auth)

20121 (CONF-720705–, pp E7-1-E7-6) SELF-CONSISTENT FINITE-AMPLITUDE WAVE DAMPING. Oei, I. H.; Swanson, D. G. Jul 1972.

From first topical conference on RF plasma heating; Lubbock, Texas, USA (6 Jul 1972).

In proceedings of the first topical conference on rf plasma heating.

An approximate self-consistent damping rate for a finite-amplitude wave is obtained. In the limit of $\gamma_L \tau_o >> 1$ and $\gamma_L \tau_o >> 1$, where γ_L is the linear damping coefficient and τ_o is the bounce period of the particles in the wave potential well, the linear Landau damping rate and O'Neil damping coefficient, respectively, are recovered from the generalized result, which is in the form of an integral equation. By the technique of numerical iteration, the damping coefficients were obtained for different values of $\gamma_L \tau_o$ ranging from 0.1 to 1. Damped wave amplitudes are also plotted which show semiquantitative agreement with the experimental data of Malmberg and Wharton (Phys. Rev. Lett., 19: 775(1967)). (auth)

20122 (ITF-72-153-E) FIVE-WAVE INTERACTION: A POSSIBILITY FOR ENHANCEMENT OF OPTICAL OR MICROWAVE RADIATION BY NONLINEAR COUPLING BY EXPLOSIVELY UNSTABLE PLASMA WAVES. Wilhelmsson, H.; Pavlenko, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 19p. Dep. NTIS (U.S. Sales Only) $3.00.

A rigorous solution is obtained to the problem of five-wave interaction in a plasma medium for the case where two of the waves are transverse electromagnetic waves, whereas the remaining three waves are longitudinal plasma or beam waves. The effects of nonlinear instability are studied in a coherent wave description. As a result, enhancement of radiative waves that may occur in the media is of interest to high-power laser and present-day astrophysical research. (auth)

20123 (LA–5250-PR, pp 65-72) EXPERIMENTAL PLASMA PHYSICS GROUP PROGRAM. Jun 1973.

LASL Controlled Thermonuclear Research Program.

The anomalous absorption of large amplitude electromagnetic waves near the electron plasma frequency is investigated. Weak-field resistivity, the effect of heat conduction, threshold determinations, spectral evidence for the parametric decay instability, strong-field resistivity and anomalously heated electrons, and computational studies of parametric instability properties are some of the areas described in relation to anomalous absorption of microwave signals. (MOW)

20124 (N-73-18725) PERFORMANCE OF AN ION-CYCLOTRON WAVE PLASMA APPARATUS OPERATED IN THE RF SUSTAINED MODE. Swett, C. C.; Woollett, R. R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1973. 43p. (NASA-TN-D-7187). NTIS.

An experimental study was made of an ion-cyclotron-wave apparatus operated in the rf-sustained mode, i.e., a mode in which the Stix rf coil both propagates the waves and maintains the plasma. Problems associated with this method of operation are presented. Some factors that are important to the coupling of rf power are noted. In general, the wave propagation and wave damping data agree with theory. Some irregularities in wave fields are observed. Maximum ion temperature is 870 eV at a density of 5×10^{12} cm^3 and rf power of 90 kW. Coupling efficiency is 70%. (auth)

20125 BEAM–BEAM PLASMA INTERACTION PHENOMENA IN A MAGNETIC FIELD. Gheorghe, V. N. Bucharest; Univ. of Bucharest (1970). 35p. (In Rumanian).

Thesis.

The system of two opposite electron beams of equal density within a magnetic field and an electron–ion plasma was investigated. Theoretical treatment of the beam–plasma interaction in the magnetic field, treated under consideration of the collision and temperature effects on the basis of the kinetic equation formalism, yielded a model that was able to correlate much previous literature data. The generalized dispersion relations and solution of the transverse and longitudinal oscillations were derived from electrical permittivity data. It was found that temperature effects cause a shift in the dispersion, while collisions induce damping and amplification phenomena in the concentration and dispersion of the waves. Relatively high-frequency high-intensity oscillations were obtained in the 140- to 1000-MHz range. The volt–ampere characteristics revealed that the high-frequency oscillation spectrum was obtained under abnormal luminescent discharge. (147 references) (TTT)

20126 MODULATION INSTABILITY OF ELECTRON PLASMA WAVES. Ichikawa, Y. H. (Nihon Univ., Tokyo); Suzuki, T.; Taniuti, T. J. Phys. Soc. Jap.; 34: No. 4, 1089-1092(Apr 1973).

A modified nonlinear Schroedinger equation obtained on the basis of the reductive perturbation theory is compared with one obtained by Dewar applying the Lagrangian method. It is shown that both results agree for a special case of the one-dimensional electrostatic modes in a collisionless plasma. In a case of the electron plasma wave, the nonlocal nonlinear term of the modified nonlinear Schroedinger equation leads to a modulational instability, which is reduced to the nonlinear Landau damping in the limit of small amplitude. (auth)

20127 PROPAGATION OF SOLITARY PULSES IN INTERACTIONS OF PLASMA WAVES. Nozaki, K.; Taniuti, T. (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 34: No. 3, 796-800(Mar 1973).

By using the theory of a steady propagation of solitary pulses in three-wave interactions in nonlinear optics, the possibility of the same effect is suggested in nonlinear interactions of plasma waves. (auth)

20128 NONLINEAR SCHROEDINGER EQUATION FOR LANGMUIR WAVES. Fried, B. D. (Univ. of California, Los Angeles); Ichikawa, Y. H. J. Phys. Soc. Jap.; 34: No. 4, 1073-1082(Apr 1973). (In Japanese).

A direct derivation of the nonlinear Schroedinger equation for Langmuir waves is presented, based upon the nonlinear wave packet ansatz of Karpman and Krushkal. Both fluid and Vlasov equation formulations are used. The results obtained are essentially equivalent to those found earlier by Taniuti, et al., using reductive perturbation theory, including the importance of wave–particle resonances at the group velocity for the long time be-

havior of the amplitude of modulated waves. Separating the wave packet considerations from the calculation of the nonlinear frequency shift makes it possible to attack the latter with whatever method facilitates the analysis of that part of the problem. In addition, certain ambiguities concerning singularities in velocity integrations are resolved, and the connection with a well-posed initial value problem is made somewhat clearer. This method can be used equally well for other waves, and may be of help particularly in situations where it is not clear, a priori, what scaling to adopt in applying reductive perturbation theory. (auth)

20129 RENORMALIZATION OF THE WAVE-PARTICLE INTERACTION IN WEAKLY TURBULENT PLASMAS. Kono, M. (Tokyo Univ.); Ichikawa, Y. Progr. Theor. Phys. (Kyoto); 49: No. 3, 754-763(Mar 1973).

Partial summation of the perturbation terms is carried out by renormalizing the propagator of the nonlinear Vlasov equation. The present analysis of the renormalization procedure clarifies the importance of taking into account not only the most secular terms, but also the dominant parts of the secondary most secular terms. It also accomplishes nontrivial generalization of the previous results of Dupree and Weinstock on the modification of the wave–particle interaction. (auth)

20130 EXCITATION OF BERNSTEIN MODE IN AN INHOMOGENEOUS COLLISIONLESS PLASMA. Hiroe, S. (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 34: No. 5, 1330-1366(May 1973).

Cyclotron harmonic waves, propagating at right angles to the static magnetic lines of forces, are excited in an inhomogeneous plasma. The measured dispersion relations are in good agreement with a collisionless theory, not only qualitatively but also quantitatively. It is made clear that the excited waves propagate within the core of the plasma bounded by the upper hybrid (ω_p^2 (r) > $\omega^2 - \omega_c^2$), and these waves are propagating rather than standing. (auth)

20131 NUMERICAL SIMULATION OF THE INTERACTION OF A SMALL RESONANT ELECTRON BEAM WITH A COLD ELECTRON–CYCLOTRON WAVE. Sestero, A. (Euratom–CNEN, Frascati, Italy); Bittoni, E.; Taroni, A. Lett. Nuovo Cim.; 7: No. 11, 443-448(14 Jul 1973).

Some results from a numerical experiment are described. It is shown how nonlinearity affects the growth or damping of the wave. The numerical model for simulation of the nonlinear interaction process is described. (MOW)

20132 ION SOUND THEORY IN AN INFINITE PLASMA WITH ELECTRIC FIELD. Rohlena, K. (Inst. of Physics, Prague). Czech. J. Phys.; 23: No. 7, 728-735(1973).

Stability of the electroacoustic wave in an infinite one-dimensional plasma with a dc electric field is analyzed. Residual charged particle–neutral collisions are modeled by a BGK term. With the ion collisions weak, the effect of ion acceleration in the dc electric field is taken into account. Conditions for unstable propagation are discussed. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 18912, 19802, 19852, and 19955.

20133 (AD-757305) APPLICATION OF JACOBI POLYNOMIAL METHODS TO THE ONE-SPEED TRANSPORT EQUATION. Mueller, G. P. (Naval Research Lab., Washington, D. C.). 6 Mar 1973. 30p. NTIS.

The transport equations associated with radiation damage studies are often solved using expansions in Legendre polynomials. The radiation damage distribution functions may be sharply peaked in the forward direction, while the Legendre polynomials, as a set, are isotropic. This requires the use of many terms in the Legendre expansion. The Jacobi polynomials, on the other hand, can have strong peaking built into their associated weight function. To test the usefulness of these polynomials they are used to solve the simple, one-speed, neutron transport equation. The results are then compared to the exact theory and to the results of applying Legendre methods to the same problem. This sample calculation demonstrates the clear advantage of the Jacobi polynomials in strongly nonisotropic situations. (auth) (NTIS)

20134 (CEA-N-1569) GENERATION OF A POISSON DISTRIBUTION. Application to the Simulation of Measurements of Decaying Activity of Radioisotopes. Becker, A.; Lame, J.; Vallee, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1973. 30p. (In French). Dep. NTIS (U.S. Sales Only) $3.50.

Investigations were conducted to enable metrologists measuring half-lives to establish objective comparisons between the estimations used. The definitions concerning distribution functiors and probability densities are reviewed together with the transformation of these densities for very simple cases. Transformation by inversion is then presented. In this way, it is possible (at least in principle) to account for the transition from a uniform distribution to any other distribution. In particular, it is shown how the distribution of intervals generates whole number distributions following a Poisson law with a given parameter. The FORTRAN IV subroutines and main program for radioactive measurement simulation (free from instrumental defects) are given in full. (FR)

20135 (CONF-730907-2) TABULATION OF SPECIFIC EFFECTIVE ENERGIES FOR DOSE CALCULATIONS. Ford, M. R.; Snyder, W. S. (Oak Ridge National Lab., Tenn.). 1972. 10p. Dep. NTIS $3.00.

From 3rd international congress of the International Radiation Protection Association meeting; Washington, District of Columbia, USA (9 Sep 1973).

A tabulation is presented of the energy absorbed per gram in various target organs per disintegration of a radionuclide in a source organ. For each radionuclide and each source and target organ, the energy absorbed due to photons, to beta-like radiation, to alpha particles, and to recoil nuclei is given, each weighted with the appropriate quality factor recommended by ICRP and NCRP. The total specific effective energy is listed also. The source-target organs include bone and active bone marrow and bone and endosteal cells as well as the organs usually considered in radiation protection programs. The absorbed fractions of photon energy have been recomputed in a more realistic phantom using the methods developed in MIRD Pamphlet 5. When the Monte Carlo calculation did not give a sufficiently accurate result, various approximate procedures were used, and these are described. The tabulation is convenient to use because it avoids separate consideration of each product of the decay scheme and does not imply any restriction on the metabolic model to be used. However, the sources are considered to be uniformly distributed in the source organ, and only a mean energy deposition in the target organ is estimated. (auth)

20136 (ITJ-30) ABSORPTION OF THE GAMMA RADIATION IN INHOMOGENEOUS MEDIA. Gyurcsak, J.; Umiastowski (Institute of Nuclear Techniques, Krakow (Poland)). Nov 1972. 66p. Dep. NTIS (U. S. Sales Only) $5.50.

The results of the Monte-Carlo calculations carried out in order to investigate gamma-ray absorption in inhomogeneous media are presented. Modeled inhomogeneous media were composed of spherically shaped grains randomly distributed in a continuous medium being the matrix. The calculations were done for Fe_3O_4 in water and $BaSO_4$ in H_3BO_3 mixtures. The photons energies were 22.6 keV, 41.4 keV and 60 keV. The influence of the grain size and concentration of the admixture as well as the influence of the photons energy and sample thickness, on the absorption of gamma radiation were examined. An unexponential dependence of the gamma radiation attenuation on the absorber thickness was obtained. (auth)

20137 (LA-4848-MS) TWOTRAN-II: AN INTERFACED, EXPORTABLE VERSION OF THE TWOTRAN CODE FOR TWO-DIMENSIONAL TRANSPORT. Lathrop, K. D.; Brinkley, F. W. (Los Alamos Scientific Lab., N. Mex.). Jul 1973. Contract W-7405-eng-36. 71p. Dep. NTIS $5.45.

TWOTRAN-II solves the two-dimensional multigroup transport equation in (x, y), (r, Θ), and (r, z) geometries. Both regular and adjoint, inhomogeneous and homogeneous (k_{eff} and eigenvalue searches) problems subject to vacuum, reflective, periodic, white or input specified boundary flux conditions are solved. General anisotropic scattering is allowed and anisotropic inhomogeneous sources are permitted. The discrete ordinates approximation for the angular variable is used in finite difference form which is solved with the central (diamond) difference approximation. Negative fluxes are eliminated by a local set-to-zero and correct algorithm. Standard inner (within-group) and outer iterative cycles are accelerated by coarse-mesh rebalancing on a coarse mesh which may be independent of the material mesh. (MHR)

20138 (LA-5176) G^3: GENERAL PURPOSE GAMMA-RAY SCATTERING PROGRAM. Malenfant, R. E. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 45p. Dep. NTIS $4.00.

GGG (G^3) is the generic designation for a series of computer programs that enable the user to estimate gamma-ray scattering from a point source to a series of point detectors. Program output includes detector response due to each source energy, as well as a grouping by scattered energy in addition to a simple, direct beam result. Although G^3 is basically a single-scatter program, it also includes a correction for multiple scattering by applying a buildup factor for the path segment between the point of scatter and the detector point. Results are recorded with and without the buildup factor. Surfaces, defined by quadratic equations, are used to provide for a full three-dimensional description of the physical geometry. G^3 evaluates scattering effects in those situations where more exact techniques are not economical. (auth)

20139 (N-73-19698) ELECTRON EMISSION PRODUCED BY PHOTOINTERACTIONS IN A SLAB TARGET. Thinger, B. E.; Dayton, J. A. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1973. 19p. (NASA-TM-X-2756). NTIS.

The current density and energy spectrum of escaping electrons generated in a uniform plane slab target which is being irradiated by the gamma flux field of a nuclear reactor are calculated by using experimental gamma energy transfer coefficients, electron range and energy relations, and escape probability computations. The probability of escape and the average path length of escaping electrons are derived for an isotropic distribution of monoenergetic photons. The method of estimating the flux and energy distribution of electrons emerging from the surface is outlined, and a sample calculation is made for a 0.33-cm-thick tungsten target located next to the core of a nuclear reactor. The results are to be used as a guide in electron beam synthesis of reactor experiments. (STAR) (auth)

20140 (ORNL-4853) DOMINO, A GENERAL PURPOSE CODE FOR COUPLING DISCRETE ORDINATES AND MONTE CARLO RADIATION TRANSPORT CALCULATIONS. Emmett, M. B.; Burgart, C. E.; Hoffman, T. J. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 123p. Dep. NTIS $5.45.

A method of coupling two-dimensional discrete ordinates calculations with Monte Carlo calculations is incorporated in the DOMINO code. In particular, DOT, a two-dimensional discrete ordinates code, has been coupled with MORSE, a Monte Carlo code. The discrete ordinates calculation is limited to an r-z geometry. Either the DOT boundary angular fluxes or the angular fluxes at internal surfaces may be input to DOMINO. Any amount of surface may be used in DOMINO; i.e., from all mesh intervals down to a portion of one interval. The radii, axes, and quadrature set must be read into DOMINO. Appropriate cumulative probability distributions are calculated from the angular fluxes and written on a DOMINO tape. Four different types of DOMINO tapes may be written for use in Monte Carlo codes — upward from a disk, downward from a disk, inward from a cylindrical surface, and outward from a cylindrical surface. The DOMINO tape contains all necessary coupling information for use by the Monte Carlo code. The MORSE calculation may utilize this data in four ways: (1) as a source for a forward MORSE case; (2) as a scoring function for an

adjoint MORSE case; (3) as a source for an adjoint MORSE case; or (4) as a scoring function for a forward MORSE case. A detailed discussion of the coupling operation as well as a sample problem are included in the appendices. Logical flow charts of the routines are also presented. (auth)

20141 (PRNC-163) EXPERIMENTAL DETERMINATION OF ABSORBED GAMMA DOSES IN LEAD CYLINDERS. Gileadi, A. E.; Griffin, L. (Puerto Rico Nuclear Center, Mayaguez). Apr 1973. Contract AT(40-1)-1833. 62p. (In Spanish). Dep. NTIS (U. S. Sales Only) $5.25.

Thesis. Submitted to Puerto Rico Univ., Mayaguez.

The effect of gamma heating has been studied exposing a set of lead cylinders to (a) gamma rays emitted by a cobalt-60 source of approximately 7000 curies source strength, (b) the gamma field existing inside the thermal column of the RV-1 reactor (Reactor Venezolano-1), and measuring the resulting temperature distribution with respect to time and space. Irradiations were carried out under the following boundary conditions: (a) free heat exchange on the lead-air interface; (b) surrounding the absorber with partial vacuum, thus creating quasiadiabatic boundary conditions. The time rates of the absorbed dose as well as the heat transfer coefficients were determined from experimental data using the basic heat balance equation. (auth)

20142 (SLA-73-562) APPROXIMATION FOR X-RAY CROSS SECTIONS. Sullivan, T. D. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 26p. Dep. NTIS $3.50.

Analytical approximations convenient for use on electronic desk-top calculators are given for the photoelectric, total, and energy absorption cross sections for photons in the energy range of 1.0 keV to 150.0 keV. All elements of atomic number 1 through 100 are included. (auth)

20143 COMPUTERIZED CALCULATION OF THE REAL DOSE DISTRIBUTION AROUND INTERSTITIALLY IMPLANTED IRIDIUM 192 LOOPS AND PINS. Rosenwald, J. C.; Dutreix, A.; Chassagne, D.; Pierquin, B. (Institut Gustave Roussy, Villejuif, France). J. Radiol., Electrol., Med. Nucl.; 54: No. 1, 47-50 (Jan 1973). (In French).

A program, which can be used on any computer with sufficiently large capacity is used for the accurate evaluation of the dose distribution around any given iridium configuration. The basic information required for the determination of the position of the wire in space is obtained from two orthogonal radiographies (a front view and a profile). The calculation program associates the corresponding points in the two pictures. In this way, the real position of the wire is established in space. Calculations can also be performed in a number of planes and the isodose curves established used to evaluate a three dimensional representation of the dose distribution. (FR)

20144 CLASS OF SECOND-ORDER APPROXIMATE FORMULATIONS OF DEEP PENETRATION RADIATION TRANSPORT PROBLEMS. Gerstl, S. A. W.; Stacey, W. M. Jr. (Argonne National Lab., IL). Nucl. Sci. Eng.; 51: No. 3, 339-343(Jul 1973).

The relationship among several approximate formulations-variational, adjoint difference, forward difference, perturbation-for the solution of deep penetration radiation transport problems is established. An expression for the theoretical error associated with each method is derived, and a strategy for the application of the newly introduced forward difference approximation is discussed. (auth)

20145 MONTE CARLO CALCULATION OF NEUTRON REFLECTION FROM VARIOUS CURVED SURFACES. Kalter, C. J. Rolla, MO; Univ. of Missouri (1972). 80p. University Microfilms Order No. 73-17,083.

Thesis (Ph. D.).

Plane parallel neutron beams normally incident upon the curved surface of a solid reflector are studied with the Monte Carlo method. The geometries studied are cylindrical, parabolic, and hemispherical. It is shown that when the curved surface is cylindrical, a small "focusing effect" occurs in the reflected neutron beam. Parabolic and hemispherical surfaces do not show "focusing." A study of the factors which determine the spatial dependence of the reflected flux shows that the probability of emergence of a neutron, traveling a fixed distance from a point inside the reflector, depends upon the curvature of the surface. It is only for cylindrical geometry that this probability as a function of distance shows a "peak" which results in "focusing." (Diss. Abstr. Int., B)

20146 SHAPING THE DISTRIBUTION OF ELECTRON RADIATION BY MEANS OF WOOD-METAL. Rytila, A.; Koskinen, M. (Univ. Central Hospital, Helsinki). pp 88-90 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The change in the absorbed dose at a certain point of the phantom when a wood-metal shield is placed before the radiation field was measured. Thermoluminescence dosimetry was used in these relative measurements. The TLD measurements were performed in a polystyrene phantom. The field size was 4×8 cm^2. The measurements were made along the central axis at depths ranging from 0 to 5 cm. (MHR)

20147 DERIVATIVE OF THE SCATTER-AIR RATIO IN DOSE CALCULATIONS FOR FILTERED COBALT-60 FIELDS. Patomaki, L. (Univ. of Kuopio, Finland). pp 91-93 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

The use of the derivatives of the scatter-air ratios has been introduced for calculation of percentage depth dose values in a wedge field. Calculation gives as a result that percentage depth dose values are greater in a wedge field and the relative difference at 10 cm depth is a few percentages. (auth)

20148 COMPARISON OF DOSES WITH CALCULATIVE AND EXPERIMENTAL METHODS IN IRREGULARLY SHAPED COBALT-60 FIELDS. Rytila, A.; Verho, S. (Univ. Central Hospital, Helsinki). pp 94-96 of Proceedings of the First National Meeting on Biophysics and Biotechnology in Finland. Patomaki, L. (ed.). Helsinki; Technical Research Centre of Finland (1973).

From first national meeting on biophysics and biotechnology; Helsinki, Finland (4 Jan 1973). See CONF-730121-.

Calculation methods and other approximation procedures have been evolved for dose determination. A calculation method and its application in practice were examined. The calculation results were compared with experimental measurements with LiF dosimeters in an anatomic Alderson phantom. (MHR)

20149 CHARACTERISTICS OF THE DOSE FIELD OF ^{60}Co γ-RADIATION THROUGH GRID FILTERS. Nguyen Van Thien. Med. Radiol.; 18: No. 6, 56-61(Jun 1973). (In Russian).

For using two miniature detectors distribution of effective energy and percentage of depth doses of fields of γ-radiation ^{60}Co in the phantom through lead grids were determined. The influence of the projection size of holes in the phantom grid, the ratio of closed areas to open ones of the grid, and the area of the field of irradiation on effective energy are underlined. Great influence on the distribution of percentage dose through grid filters is exercised by the area ratio and the projection size of the holes in the phantom. The size of irradiation fields was of no practical importance. (auth)

20150 DETERMINATION OF INTEGRAL PARAMETERS OF NEUTRON INTERACTIONS IN CARBON. Shchebolev, V. T. At. Energ. (USSR); 34: No. 4, 291-293(Apr 1973). (In Russian).

A series of experiments on neutron energies and the distribution of thermal neutrons in graphite was conducted with a four-meter diameter graphite sphere with a central cavity with a diameter of 4 cm. A neutron source and a Cd sphere provided the thermal neutrons: neutron sources tested were T(d,n), Pu-Be, Ac-Be, Pa-Be, Po-Be, and T(d,n). (KSW)

20151 DISTRIBUTION OF IONIZING RADIATION ENERGY IN HETEROGENEOUS DISPERSE SYSTEMS. Popova, L. V.; Mingaleev, G. S.; Sugak, L. S.; Rumyantsev, S. A. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 209: No. 4, 897-899(1973). (In Russian).

The absorption of the energy of ^{60}Co-emitted gamma radiation and its subsequent transfer into an infinite, ideally mixed heterogeneous medium was investigated. The heterogeneous medium was composed of a liquid and a metal dispersed in it, e.g., Al, Cu, or Pt dispersed in H_2O, or Sn dispersed in butyl bromide, with the particle diameter ranging from 10^{-3} to 10^{-1} cm. The effectiveness of energy transfer by electrons became greater with reduction of dispersed particle size, or with increase in the atomic number of the metal in the solid phase. (KSW)

20152 DETERMINATION OF DIFFERENT ISODOSE PATTERNS FOR TELECOBALT FIELDS WITH ILFORD LINE N 5.50. Awwad, H. K.; Abd-Elazim, A.; Nooman, M. F. (Univ., Cairo). J. Radiol., Electrol., Med. Nucl.; 54: No. 1, 35-38(Jan 1973).

Ilford Line N 550 film was used to study the dose distribution obtained using a ^{60}Co radiation beam. The films were placed in a wax phantom at different depths. The irradiation was effected perpendicularly to the axis of the beam. A method developed by Mauderli and Stanton, which involves removing part of the phantom behind the film, was adopted in order to avoid errors caused by

the energy dependence of the film response. A Chisotron type unit was used for the exposure, and dose distributions were obtained in different planes, wedge filters being used. In this way isodose curves were constructed. The results are compared with those obtained using a Baldwin Farmer ionization chamber in a water phantom. The discrepancy between the two methods varies between 0.3 and 3%. It was found that Ilford films have linear responses up to 80 rads and can thus be used in conjunction with measuring equipment for high doses. (FR)

20153 EXPERIMENTAL STUDY OF THE COLLIMATION OF AN ELECTRON BEAM USING AN ADJUSTABLE LEAD DIAPHRAGM. Briot, E.; Dutreix, A.; Dutreix, J.; Penet, A. (Institut Gustave Roussy, Villejuif, France). J. Radiol., Electrol., Med. Nucl.; 54: No. 1, 39-46(Jan 1973). (In French).

Experimental studies of the collimation of the electron beam produced by a linear accelerator demonstrate that lead diaphragms can fulfill the following optimum conditions: high lateral beam definition with only a small width shadow; only slight contamination of the principal beam by scattered electrons and bremsstrahlung x-rays. In the case of energies greater than 20 MeV, the x-ray collimator developed fulfills these optimum conditions. At lower energies, an additional collimator is required, this collimator being constructed from 1-cm-thick lead and fixed to the principal x-ray collimator. (FR)

20154 EMPIRICAL TREATMENT OF ENERGY DISSIPATION OF FAST ELECTRONS AT NORMAL INCIDENCE IN SEMI-INFINITE TARGETS. Lantto, V. (Oulu Univ., Finland). J. Phys., D (London); 6: No. 9, 1058-1066(11 Jun 1973).

In an investigation of the penetration of a beam of fast electrons in a solid, a simple empirical method has been used for calculating the distribution of the energy dissipation by electrons in a semi-infinite target. The calculations are based on the values of the distribution function tabulated by Spencer (Phys. Rev.; 98: 1597-615 (1955)) for an infinite target. The method has been applied to obtain the distribution for 25, 50 and 100 keV electrons at normal incidence in aluminium, copper, tin and lead. The calculated differences in the dissipation distribution between the infinite and the semi-infinite cases agree fairly well with the results of the Monte Carlo calculations by Bishop (Br. J. Appl. Phys.; 18: 703-15 (1967)). A comparison with the experimental distribution measured in a metal-oxide-semiconductor system is also presented. (auth)

20155 MONTE CARLO CALCULATIONS ON CHEST X-RAY EXAMINATIONS FOR THE DETERMINATION OF THE ABSORBED DOSE AND IMAGE QUALITY. Koblinger, L.; Zarand, P. (Kozponti Fizikai Kutato Intezet, Budapest). Phys. Med. Biol.; 16: No. 4, 518-531(Jul 1973).

The dose absorbed in internal organs is not measurable during diagnostic x-ray examinations and Monte Carlo calculation techniques can be used in their determination. Some results of relevance to chest radiography are presented, and the doses absorbed by the different parts of the inhomogeneous Snyder phantom as well as the quality of the image on a nonscreen film are calculated. By increasing the tube voltage the dose decreases in directly irradiated organs but increases in the organs which absorb only scattered radiation. The use of a grid increases the dose by a factor of more than two for the same film density. Two quantities characterizing the contrast are defined and examined as a function of the tube voltage, with and without grid. From the results of computations carried out for phantoms of different sizes, it is concluded that larger phantoms absorb a greater dose. During fluoroscopic examinations the incident exposure distribution is not uniform over the irradiated area. This effect is simulated and the increase in dose in the central area and its reduction in more distant regions are calculated. The deviations between the results for parallel beam and point source models are examined. (auth)

20156 FINDING OF THE ELEMENTARY SOLUTIONS OF A MULTIVELOCITY TRANSPORT EQUATION. Shulaya, D. A. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 70: No. 3, 545-548(Jun 1972). (In Russian).

A method of solving the γ-ray equation in plane geometry in the case of anisotropic scattering and energy dependence is presented. (auth)

20157 ANNIHILATION RADIATION APPEARING IN BARRIERS OF FINITE THICKNESS DURING THEIR BREMSSTRAHLUNG IRRADIATION. Zol'nikov, P. P.; Dvinyaninov, B. L.; Sukhanova, K. A. Tr. Ural. Politekh. Inst.; No. 189, 38-41(1971). (In Russian).

Studies were made on the bremsstrahlung irradiation (from a betatron with a maximum energy of 10, 15, and 15 MeV of the barriers: Al, Fe, and Pb, respectively, of different thicknesses. Monte Carlo calculations were made. The annihilation radiation increased with increase in the thickness of the barrier until the maximum was attained, followed by a gradual decrease. As the atomic number of the absorber decreased, the maximum shifted toward greater thickness. On lowering the energy of initial irradiation, the character of the waves of the dependence of the intensity on barrier thickness did not change. (MHR)

20158 FIRST SCATTER TO OFF-AXIS POINTS AND THE CLARKSON METHOD. Thames, H. D. (Univ. of Texas, Houston). Phys. Med. Biol.; 18: No. 3, 444-451(May 1973).

A method is developed for the ab initio calculation of first scatter to off-axis points in a telecobalt beam. Results are compared, for small depth and beam radius, with scatter functions obtained by Clarkson's method. (auth)

20159 NEUTRON BEAM DOSIMETRY AT THE NRL CYCLOTRON. Attix, F. H.; Theus, R. B.; Shapiro, P.; Surratt, R. E.; Nash, A. E.; Gorbics, S. G. (Naval Research Lab., Washington, DC). Phys. Med. Biol.; 16: No. 4, 497-507(Jul 1973).

A 35 MeV deuteron beam impinging upon a thick Be target is being employed to generate a neutron beam for radiobiological experiments of relevance to later possible fast neutron therapy trials. The primary calibration of the beam has been based upon tissue-equivalent plastic ionization chambers, calibrated in turn with ^{60}Co γ-rays. Several different gases were employed in these chambers, and suitable corrections made to account for gas density, W, and stopping power. These corrections are discussed in detail. CaF_2: Mn and ^{7}LiF (TLD-700) thermoluminescent dosemeters have been employed to determine the γ-ray dose component in the neutron beam, by a method depending upon the ratio of fast neutron sensitivities of the two phosphors. It is shown that the fast neutron response of CaF_2: Mn is probably about 0.6 times that of ^{7}LiF, consistent with the results of Bewley and Parnell (Br. J. Radiol.; 42: 281 (1969)), but not with other published values for CaF_2: Mn. (auth)

20160 RELATIVE BIOLOGICAL EFFECTIVENESS OF HIGH-ENERGY ELECTRON AND BREMSSTRAHLUNG RADIATION. Kovalev, V. P.; Tsuladze, N. G.; Kapchigashev, S. P. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Med. Radiol.; 18: No. 6, 54-55(Jun 1973). (In Russian).

A comparative study was made of the RBE of standard γ-radiation from ^{60}Co and a mixed radiation containing different ratios of electron radiation and bremsstrahlung. A culture of the yeast Saccharomyces was exposed to a range of intensities of radiation, and the survival rate was measured by a macrocolony count in Petri dishes. The data indicated that the RBE of fast electrons and γ radiation from ^{60}Co were identical. The RBE of 25 MeV bremsstrahlung was greater than electron and γ-radiation. (KS)

20161 LOW-ENERGY COMPONENTS OF SCATTERED GAMMA RADIATION. 2. Calculation of The Energy Spectra of Reflected Gamma Radiation By Monte Carlo Method. Minato, S. (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku; 21: No. 7, 176-180(Jul 1972). (In Japanese).

Spectra of reflection of several times scattered gamma rays in a medium were calculated by the Monte Carlo method. Dependences of the spectra on the source energy, the thickness of a medium and the atomic number of the medium were studied. Shapes of high-energy components of the reflection spectra were found to be considerably different from those for the case of transmission. On the other hand, shapes of low-energy components were quite similar to those for the case of transmission. Thus, the spectrum had a peak in the low-energy region. The energy corresponding to the peak was barely dependent on the source energy or the thickness of the medium. However, it was strongly dependent on the atomic number of the medium. Dependence of the spectra on the number of scatterings was also studied. (auth)

20162 ELECTRON DOSE DISTRIBUTION MEASUREMENTS BY MEANS OF FILMS AND TLD DETECTORS UNDER OBLIQUELY INCIDENT RAYS AND ON PHANTOMS WITH INHOMOGENEITIES. Glaeser, L.; Rassow, J. (Bochum Univ., Essen). Strahlentherapie; 145: No. 5, 538-548(1973). (In German).

The "isodose curve shift method" under oblique incidence of the rays on phantoms with inhomogeneities, already known for photon radiation, is also applicable to electron radiation. Shifting factors for extended equal inhomogenous layers (lungs, bones) are experimentally determined. The measured values, under oblique incidence of the electron rays on the phantoms, are described in detail with reference to the dose distribution under vertical incidence after an isodose shifting of 0.075 h; here, the symbol h means the superficial distance between the obliquely and vertically situated phantom, along straight lines, pointed at the focus. The suitability of films for the dosimetry on inhomogeneous phantoms is discussed by the example of a cylindric bone-embedding. Faults in the read-out are reduced by pendulum irradiation. (GE)

20163 PROBLEMATIC NATURE OF PERSONAL DOSIMETRY. Wagner, S. (Physikalisch-Technische Bundesantalt, Brunswick). Atomkernenergie; 21: No. 2, 153-156(1973). (In German).

Starting from the terminology as used without further explanation by official radiation protection regulations in connection with personnel radiation exposure, it is shown on the basis of existing definitions of dose quantities that the dose limits laid down for radiation protection relate to the dose equivalent in the critical organ. This quantity is called "body dose" in German Standards. In radiation monitoring of photons, the absorbed dose at the place of the personnel monitoring device on the body may be taken as a sufficient approximation in view of the permitted uncertainties. For neutrons, however, detector devices should be developed, the indication of which is proportional to the "body dose" in a standard phantom independent of neutron energy. (GE)

20164 DEPTH DOSE DISTRIBUTIONS DUE TO 14 MeV NEUTRONS. McGinley, P. H. (Longwood Coll., Farmville, VA). Health Phys.; 25: No. 2, 191-194(Aug 1973).

A study undertaken to obtain experimental depth dose data for 14 MeV neutrons and to compare dose values measured in a tissue equivalent phantom exposed to a diverging beam with dose values calculated by the Monte Carlo method for a broad parallel beam is described. It was found that the ionization chamber measurements in the phantom were consistent with the calculated values. (UK)

20165 ABSORPTION OF BETA PARTICLES IN MATTER. Mudhole, T. S. (Univ. of Karnatak, Dharwar, India). J. Phys., A (London); 6: No. 7, L95-L97(Jul 1973).

The fraction f_A of the incident beta particles from a pure beta source that are completely absorbed in a foil of thickness t is measured with an end-window GM counter for ^{32}P, ^{91}Y and ^{89}Sr beta sources using different thicknesses of Cu, Ag, Sn and Pb targets. The variation of f_A as a function of foil thickness is shown to follow an empirical relation of the type $t \exp(-\Sigma_A t)$, where Σ_A is a constant. The values of Σ_A agree with each other within 15 to 20% for all these sources and the targets used. (auth)

20166 X RADIATION SCATTERED FROM PATIENT PHANTOMS; QUANTITY AND QUALITY AND ANGULAR DISTRIBUTION. Kraft, A.; Blauth, C. (Gesellschaft fuer Strahlen und Umweltforschung mbH, Nuremburg). Roentgenpraxis; 26: No. 5, 115-123(1973). (In German).

The investigations reported were done for the preparation of a revised version of DIN 6812, which includes among others a method for calculating the efficiency of protective layers to reduce the scattered radiation in x-ray equipment for medical use. The experiments have shown that the scattering effect in water phantoms is quite equivalent to that of the human body. The scatter doses to be expected within a radius of 100 cm at voltages between 70 kV and 100 kV for an irradiation field of 400 cm^2 is about 0.5 per thousand up to 5.0 per thousand, and for a field size of 900 cm^2 about 1.0 per thousand up to 9.0 per thousand of the incident dose. Without additional filtration, the relative scatter dose was found to reach a maximum at 200 kV and scattering angles of 90 to 180 deg. This maximum will move to lower tube voltages by filtering the radiation. The increase in the scatter dose is not proportional to the field size variation, as the rate of increase was shown to be higher than the field size variation for scattering angles between 45 and 135 deg., and lower for angles smaller than that. As to the quality of scattered radiation, it was found that the scattered radiation from x-radiation without additional filtration is much harder than the corresponding radiation itself when scattered at angles between 0 and 110 deg. In the range of 110 to 180 deg., almost no difference was observed, whereas the scattered radiation of radiations of higher tube voltages, or of strongly filtered radiations, was always relatively soft. (GE)

20167 TOTAL ABSORPTION MEASUREMENTS FOR 450–1000 MeV PHOTONS IN VARIOUS MATERIALS. Miyachi, T.; Akino, Y.; Gomi, K.; Kusumegi, A.; Mishina, M. (Tokyo Univ., Tanashi, Japan). J. Phys. Soc. Jap.; 34: No. 1, 14-17(Jan 1973).

The total absorption cross sections of photons in copper, silver, tin, tantalum, tungsten and lead have been studied for photon energies at 450, 700 and 1000 MeV. A comparison is made between experimental and theoretical cross sections. The Hartree-Fock-Slater cross section agrees with experimental results with an accuracy of the order of 1%. (auth)

20168 IMPORTANCE OF SURFACE EFFECTS IN ELECTRON ENERGY LOSS SPECTRA. Wehenkel, C. (Univ., Paris). Compt. Rend., Ser. A, B; 276: No. 12, 483-486(19 Mar 1973). (In French).

The position of the line situated in the 6 eV region of the electron energy loss spectrum was studied as a function of the thickness of the Au layer traversed. Comparisons with the spectra calculated from the complex dielectric constant demonstrate that this line partially depends on surface excitations. In more general terms, the possible role played by surface effects on the transmission spectra obtained between 2 and 20 eV is emphasized, in particular in the determination of the complex dielectric constant. (FR)

20169 EMPIRICAL EQUATION FOR THE AVERAGE ENERGY-LOSS FRACTION OF BACKSCATTERED ELECTRONS. 2. Tabata, T.; Ito, R.; Okabe, S. (Radiation Center of Osaka Prefecture, Sakai, Japan). Jap. J. Appl. Phys.; 11: No. 8, 1220(Aug 1972).

20170 LOW-ENERGY COMPONENTS OF SCATTERED GAMMA RADIATION. 4. Study On The Position Of The Peak. Minato, S. (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku; 21: No. 10, 300-304 (Oct 1972). (In Japanese).

The spectrum of multiply scattered gamma rays in a medium has a broad single peak in a low energy region. The position of the peak appears to be dependent strongly on the atomic number of the medium. The result of a theoretical treatment with respect to the peak characteristic was compared with the result obtained by Monte Carlo calculations. The following relation was found between the position, E and the atomic number, Z. $E = b \cdot Z^a$, where a and b are constants. (auth)

20171 LOW-ENERGY COMPONENTS OF SCATTERED GAMMA RADIATION. 3. Examinations With Respect To The Method Of Monte Carlo Calculation, And Influence Of Coherent Scattering On Transmission And Reflection Spectra. Minato, S. (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku; 21: No. 8, 204-224(Aug 1972). (In Japanese).

Various techniques for sampling the displacement, the energy change, and the change of direction of photons in the Monte Carlo calculation, which were required in calculating spectra of low-energy components of scattered gamma radiation, were examined. It was found that the most suitable method for determining the energy change was the composition and rejection method suggested by Kahn. Influence of coherent scattering (mainly, of Rayleigh scattering) on the spectra of transmission and reflection of scattered gamma radiation was investigated. It came to the conclusion that the influence could be disregarded in the low-energy region as well as in the high-energy region. (auth)

20172 INTERFERENCE PHENOMENA OF NEUTRON WAVES IN HETEROGENEOUS MULTIPLYING SYSTEMS. Matsumoto, T. (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 10: No. 3, 146-154 (Mar 1973).

An experimental and theoretical study was conducted on two interference effects of neutron waves in heterogeneous multiplying systems—the interference between elementary waves having greatly different characteristics of propagation and the interference due to the lattice effect, taking as example a plate-type system consisting of natural uranium and graphite. The experiments on neutron wave propagation were performed with external modulated sources. The effects examined on the neutron waves covered the multiplicity of system, the direction of propagation, and the source spectrum. Analyses by fission expansion method have proved the existence of the first-mentioned form of interference in the source transient region. The second form of interference effect on the dispersion law with account taken of heterogeneity is discussed numerically in comparison with the homogeneous multiplying system. (auth)

20173 HAZARDS IN THE USE OF X-RAY ANALYTICAL INSTRUMENTATION. Jenkins, R.; Haas, D. J. (Philips Electronic Instruments, Mount Vernon, NY). X-Ray Spectrom.; 2: No. 3, 135-141(Jul 1973).

The potential hazards in the use of x-ray analytical instrumentation are outlined. The terminology employed is defined and the causes and effects of radiation damage outlined. The national recognition of the problem which has led to present day legislation of dose levels is considered. A verbatim copy of the report "Radiation Safety Recommendations for X-ray Diffraction and Spectrographic Equipment" Moore and McDonald, MORP 68-14 is included. (UK)

20174 STUDY ON A NUMERICAL APPROACH TO THE BOLTZMANN TRANSPORT EQUATION FOR THE PURPOSE OF ANALYZING NEUTRON SHIELDS. Takeuchi, K. (Ship Research Inst., Tokyo). Senpaku Gijutsu Kenkyujo Hokoku; 9: No. 6, 323-389(Nov 1972). (In Japanese).

A numerical method for solving the Boltzmann transport equation is presented for practical neutron shielding calculations. The energy-dependent transport equation written in its general form is converted into a set of coupled one-group integral equations for each energy mesh, with the sources due both to the true source and to the elastically and inelastically scattered neutrons. The scattering source is evaluated by means of numerical integration of the scattering integral through the application of quadrature schemes. Highly anisotropic scattering is taken into account for elastic scattering, while isotropic scattering is assumed for in-

elastic scattering. The derived integral equation is solved by performing line integration over spatial $\bar{r}$ along the neutron flight path in the direction of neutron motion between successive spatial mesh intervals at each discrete direction. No iterative technique is applied in the calculation of the integral equation for the benefit of shortening the computing time and of providing always reasonable solutions. Discussions are given on the advantages and disadvantages of all the procedures which have been currently used in neutron shielding calculations. The application of the present method to a variety of actual geometries is illustrated, on the basis of which PALLAS program has been designated to perform neutron penetration calculations for one dimensional plane and spherical, and two dimensional cylindrical geometries. The calculational accuracy of the present method is judged by performing comparisons of its calculated results with analytical solutions for unscattered flux and angular distribution in plane, spherical and two dimensional cylindrical geometries, and with experimental angular spectra in water for fission neutrons from reactor core, and in graphite and polyethylene for fission neutrons from Linac source. Excellent agreement is obtained between the present calculations and analytical or experimental results. To verify the applicability of the method to practical neutron shielding calculations, further comparison is made of the calculated with the experimental results for the reaction rate of penetrated fast neutrons, through a stratified iron/water shield, with good agreement obtained between them. From the discussions on the advantages and disadvantages of the present method, it is concluded that the method is a reliable and useful tool for the analysis of neutron shields in a variety of source problems. (auth)

20175 CHANNELING PHENOMENA. Cohen, C. (Ecole Normale Superieure, Paris). Bull. Soc. Fr. Miner. Crist.; 95: No. 6, 670-683(Nov 1972). (In French).

The effects related to the channeling phenomenon are described and illustrated by various experimental results. The physical concepts underlying the comprehension of the phenomenon are introduced. Various important applications of channeling are presented. (FR)

20176 RADIOBIOLOGICAL EXPERIMENTS WITH HEAVY IONS AT THE BEVATRON. Tobias, C. A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 3, 970-972(Jun 1973).

From 5th particle accelerator conference; San Francisco, California, USA (5 Mar 1973). See CONF-730310-.

Penetration of heavy charged particles can be characterized by three basic physical facts: (1) almost no scattering; (2) abrupt increase of linear energy deposition (LET) close to the point where the particles stop; and (3) exact range-energy relationship. These facts constitute the basis of very favorable depth-dose characteristics for heavy ions to be used in radiotherapy. Availability of accelerated high LET heavy ions in the laboratory, though a recent development, has already provided us with much useful information in physics, chemistry, and radiobiology. A few aspects of the properties of accelerated heavy ions as they relate to radiobiology, and radiotherapy are discussed. (auth)

Radiation Protection Standards

Refer also to abstract 18532.

20177 SI UNITS IN RADIOLOGY AND RADIATION MEASUREMENTS. Liden, K. (University Hospital, Lund, Sweden). Health Phys.; 25: No. 2, 199-200(Aug 1973).

Radiological SI units and their equivalents expressed in the present special units are tabulated. It is seen that the SI units imply substantial changes in the numerical values of the actual quantities. The quantities absorbed dose, exposure, and activity are considered individually and the difficulties and particular problems examined. It is stressed that the safety of the patient in medicine and hospital care must be carefully considered before the responsible national authorities prescribe a change in the present system of units. The International Commission on Radiation Units and Measurements (ICRU) has as its principal objective the development of internationally acceptable recommendations regarding quantities, units and measurement of ionizing radiation and radioactivity. The ICRU therefore invites and welcomes constructive comments and suggestions regarding the possible replacement of the special radiological units 1 rad, 1 roentgen and 1 curie with derived SI units. (UK)

20178 DISCUSSION OF THE QUALITY FACTOR. Keyrim-Markus, I. B.; Popov, V. I. (Inst. of Biophysics, Moscow). Health Phys.; 25: No. 2, 176-179(Aug 1973).

A reasoned discussion is presented of the various opinions expressed over the last decade by a number of workers in the field concerning the inconsistencies in the use of the term Quality Factor when used in the definition of dose equivalent. It is concluded that the introduction of the quantity of the dose equivalent into the practice of radiation protection demands that objectively necessary efforts should be taken to develop theoretical problems and instrumentation methods of remmetry fit to be used in everyday practice. At the same time one should look for a simpler solution of the problem. (UK)

Radiation Source Calibration and Standardization

Refer also to abstract 18306.

20179 THIN 4π SOURCES ON ELECTROSPRAYED ION EXCHANGE RESIN FOR RADIOACTIVITY STANDARDIZATION. Lowenthal, G. C.; Wyllie, H. A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Int. J. Appl. Radiat. Isotop.; 24: No. 7, 415-423(Jul 1973).

Anionic and cationic ion exchange resins are prepared as suspensions in ethanol of finely ground particles (<0.3 μm) and electrosprayed simultaneously onto metallized VYNS substrates. The resins are deposited to form circular pads in the range from about 1.5 $\mu g\ cm^{-2}$ upwards and 6 to 20 mm in diameter to provide sufficient capacity for absorbing all nonvolatile ionic material in the source drop. The pads have satisfactory electrical conductivity and high physical stability, and the ions are readily diffused uniformly throughout their structure. These characteristics lead to sources with high counting efficiencies, up to 0.985 for ^{60}Co, and high reproducibilities of counting efficiencies. For ^{35}S and ^{63}Ni the reproducibilities can be within ±0.2%. By diffusing suitable pairs of radionuclides into the same resin pad one can make uniformly and homogeneously distributed sources for efficiency tracer measurements; counting efficiencies can be decreased in arbitrarily small steps by electrospraying additional resin over the source. Brief references are made to other proven applications of thin resin layers which are potentially important in the fields of radioactivity standardization and chemical analysis. (auth)

Shielding Calculations and Experiments

Refer also to abstracts 18983, 19033, 19995, 20174, and 20296.

20180 (CONF-730619-1) STUDIES OF SENSITIVITY OF SHIELD PERFORMANCE TO NUCLEAR DATA VARIATIONS. Maienschein, F. C. (Oak Ridge National Lab., Tenn.). 1972. 20p. Dep. NTIS $3.00.

From 16th meeting of the European–American Committee on reactor physics; Chicago, Illinois, USA (4 Jun 1973).

The results presented provide confirmation of the usefulness of a quantitative definition of sensitivity. The physical meaning implicit in the definition made it possible to determine directly the important reaction cross sections, in an energy-dependent fashion, for the problem studied. Furthermore, the predictive aspect of the definition is consistent with a perturbation theory approach and the potential for evaluating cross-section uncertainties and approximate representation of basic cross-section data. For the specific sodium–iron problem studied, the sensitivity analysis provided substantial confirmation of the role of total cross-section minima in deep penetration. The dominant effect of the 24.5-keV window in iron was demonstrated quantitatively in a manner that was expected, but the substantial importance of the sodium minima in the 1- to 3-MeV range was also revealed. Predictions concerning the number of Legendre expansion terms needed to represent both the sodium and iron scattering kernels were quite enlightening in that a P_1 representation for both sodium and iron were concluded to be adequate for this problem. Corroboration of this conclusion with recalculations pointed out one of the stronger predictive applications possible with this kind of sensitivity technique. (auth)

20181 (ORNL-RSIC-36) SHIELDING AGAINST INITIAL RADIATIONS FROM NUCLEAR WEAPONS. Abbott, L. S. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 181p. Dep. NTIS $11.25.

Neutrons and gamma rays released by in-air detonations of nuclear weapons undergo various types of interactions with the surrounding environment, some of which result in additional radiations being born at points far removed from the original burst location. In the absence of adequate weapons test data, designers of shields to attenuate the initial radiations (those born within the

first minute) must rely on information gained from "transport" calculations performed on large electronic computers. In such calculations the detonation and surrounding materials, including the proposed shielded structure, are mocked up as accurately as is possible and practicable, and the intensities of the radiations reaching specified locations within the structures are computed. Such calculations are extremely difficult and very time-consuming, and much of the shielding research effort during the past decade has been devoted to the development of adequate transport methods and of the necessary input data that describe neutron and gamma-ray interactions in the pertinent materials. A major result has been the successful application of the discrete ordinates and Monte Carlo transport methods to a limited number of weapons radiation shielding problems. This report, which includes an elementary description of weapons radiations and their interactions, summarizes these problems and points out both their uses and their limitations. (auth)

20182 (ORNL-tr-2658) SHIELDING OF GAMMA RADIATION BY VERY HEAVY CONCRETE WITH DENSITY OF MORE THAN 4 g/cm^3. Sprenger, H.; Krueger, F. W. Translated by R. G. Mansfield (Oak Ridge National Lab.) from Kernenergie; 15: No. 7, 232-233(1972). 6p. Dep. NTIS $3.00.

For preparation of very heavy concretes with a density of more than 4 g/cm^3 in most cases iron ores and iron shot are used. For quanta energies in the range of 0.3 to 10 MeV the effects of the different chemical composition of these concretes on the shielding effect were investigated. In this it was shown that for these concretes also, the special chemical composition can be disregarded in the majority of shielding problems and a mean attenuation function can be used. The parameters for the attenuation function are presented. (auth)

20183 APOLLO 14 AND APOLLO 16 HEAVY PARTICLE DOSIMETRY EXPERIMENTS. Fleischer, R. L. (General Electric Research and Development Center, Schenectady, NY); Hart, H. R. Jr.; Comstock, G. M.; Carter, M.; Renshaw, A.; Hardy, A. Science; 181: No. 4098, 436-438(3 Aug 1973).

Doses of heavy particles at positions inside the command modules of Apollo missions 8, 12, 14, and 16 correlate well with the calculated effects of solar modulation of the primary cosmic radiation. Differences in doses at different stowage positions indicate that the redistribution of mass within the spacecraft could enhance safety from the biological damage that would otherwise be expected on manned, deep-space missions. (auth)

PHYSICS (THEORETICAL)

General

20184 FEYNMAN PATH INTEGRAL FOR A PARTICLE WITH SPIN. Garczynski, W. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 21: No. 4, 359-362(1973).

Closed formulas are constructed, in terms of the quantum stochastic processes, representing solutions of the Cauchy problems to the Schrödinger equations describing a particle with spin. The usefulness of the time ordered stochastic integrals with respect to the quantum Brownian motion process is emphasized. The problem of including an external electromagnetic field is also discussed. (auth)

20185 LANGEVIN EQUATION METHOD FOR IRREVERSIBLE PROCESSES IN NON-LINEAR SYSTEMS. Ueyama, H. (Osaka Univ., Toyonaka, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1090-1105(Oct 1972).

A stochastic equation $\dot{A}(t) = \alpha_1\{A(t)\} + R(t)$ for a macroscopic observable A in a large system is rigorously derived from microscopic equations of motion, where $\alpha_1(a)$ is the first derivate moment of transition probability of the corresponding master equation. The correlation function of the random force satisfies $\langle R(0)R(t)\rangle = D\delta(t)$, where the diffusion constant D is given by $D = \frac{1}{2}\int \alpha_2(a)f_{eq}(a)da = -\int \alpha_1(a)af_{eq}(a)da$ by the use of the second derivate moment $\alpha_2(a)$ and the equilibrium distribution function $f^{eq}(a)$. This expression is a generalization of the Einstein relation. The stochastic equation is stochastically equivalent to the master equation with the aid of averages $\langle R(t_1)R(t_2) \ldots R(t_n)\rangle_{A(0)}$ conditional on the initial value of A and, thus, gives a new method for the study on the irreversible process. On the assumption that the random force is a Gaussian process, the stochastic equation can be considered as a generalization of the Langevin equation in a nonlinear system. A fluctuation-dissipation theorem and a general response theory are presented. A brief discussion on an extension of Onsager's relation of reciprocity to a system far away from equilibrium is also presented. (auth)

20186 FUNCTIONAL INTEGRAL REPRESENTATION OF OPERATORS AND THE WEYL QUANTIZATION RULE. Lukes, T. (University Coll. of South Wales and Monmouthshire, Cardiff). J. Phys., A (London); 6: No. 7, L77-L78(Jul 1973).

The Weyl quantization rule is shown to follow from a semi-classical expansion of an exact expression for a functional of an operator given by Feynman (Phys. Rev.; 84: 108 (1951)). (auth)

20187 FLUID INTERPRETATION OF NONRELATIVISTIC QUANTUM MECHANICS OF PARTICLES WITH SPIN. Farque, D. (Ecole Nationale Superieure des Mines, Paris). Compt. Rend., Ser. A, B; 276: No. 20, 789-792(14 May 1973). (In French).

It has already been shown how the behavior of particles with spin can be described in wave mechanics by a scalar equation containing spinorial equations. It is shown how this equation (and in consequence the spinorial equations) describes the behavior of a certain type of fluid, possessing spin and having a Hamiltonian evolution, for the case in which a velocity potential exists. In the case considered the delay in electromagnetic actions is taken into account and the internal electromagnetic potentials are included in the variables. (auth)

20188 METRIC OF TWO SPINNING CHARGED SOURCES IN EQUILIBRIUM. Parker, Leonard (University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201); Ruffini, Remo; Wilkins, Daniel. Phys. Rev. D 7: No. 10, 2874-2879 (15 May 1973).

Using the approach of Israel, Wilson, and Perjes we give the explicit form of the metric corresponding to two identical Kerr-Newman sources in equilibrium under their mutual electromagnetic and gravitational forces, with their spins oppositely oriented along a given axis. Symmetries, the complete analytic extension, the limit of infinite separation of the sources, and the two types of solution with vanishing separation are discussed. (auth)

20189 FORCES AND PARTICLES. An Outline of the Principles of Classical Physics. Pippard, A. B. Title in the Nature. Macmillan Physics Series. New York; John Wiley and Sons, Inc. (1972). 330p. $14.00.

The topics covered are kinematics, Newton's laws of motion, the inverse-square laws (Newton, Michell, Coulomb), dynamics of particles, analysis of complex dynamical systems, units and dimensions, the electrostatic field for charges and conductors in free space, dielectric materials, magnetic fields due to currents, charged particles in electric and magnetic fields, electromagnetic induction, magnetic materials, and Maxwell's displacement hypothesis and electromagnetic waves. (JFP)

20190 NUMERICAL APPROACH FOR THE SOLUTION OF THE RADIAL SCHROEDINGER EQUATION WITH ATOMIC-LIKE POTENTIALS. Moore, R. A.; Liu, C. F. (Univ. of Waterloo, Ont.). J. Comput. Phys.; 12: No. 1, 103-111(May 1973).

It is demonstrated that the removal of factors of r^l from the solutions of the linear second-order differential Schröedinger equation containing atomic-like potentials is essential under certain conditions before carrying out the numerical work. Two examples are for large l (>5) values and when derivatives of the solutions are recycled in the equation. The subsequent complications are dealt with by deriving a conceptually simple numerical procedure. The method is an extension of that due to Numerov and is reminiscent of other approaches, all having a δ^6. This is exemplified by examining the realistic hydrogen atom problem including the spin-orbit term; the results are compared to the exact solution and to the Numerov solution. It is found that the approach suggested here gives significantly better results than the Numerov (hence, comparable) method. (3 tables) (auth)

20191 NONLINEAR COUPLED OSCILLATORS: MODAL EQUATION APPROACH. Bivins, R. L. (Los Alamos Scientific Lab., NM); Metropolis, N.; Pasta, J. R. J. Comput. Phys.; 12: No. 1, 65-87(May 1973).

A one-dimensional system of equimass particles coupled by identical nonlinear springs is studied. The equations of motion are expressed in terms of the normal coordinates of the corresponding linear system. Selection rules are developed for interactions among the modes, and the number of interaction terms in the modal equations is reduced by considering the case of a single dominant mode. The equations are considerably simplified by judicious approximation, and their validity is checked by direct numerical computation. In terms of the resulting coupled Mathieu equations it is possible to investigate stability questions and to explain recent results of computational experiments. The bearing on ergodicity and time-correlation is discussed. >(9 figures, 2 tables) (auth)

20192 FOURIER TRANSFORM OF THE ZERO-MASS EXPONENTIAL SUPERPROPAGATOR. Montaldi, E. (Univ., Milan). Lett. Nuovo Cim.; 7: No. 13, 577-583(28 Jul 1973).

A simplified procedure is suggested for evaluation of the Fourier transform of the zero-mass exponential superpropagator. The procedure avoids the use of the Watson-Sommerfeld transform and involves only the well-known asymptotic behavior of the confluent hypergeometric function. It is suggested that the technique will be particularly useful in calculations with nonpolynomial zero-mass field theories, even if the coupling is not of exponential type. (LBS)

20193 DOUBLE WILSON EXPANSION OF PRODUCTS OF THREE SPINOR OPERATORS. Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 16A: No. 3, 411-422(1 Aug 1973).

An explicit evaluation of the generator condition for a current constructed as the Wilson finite part of a bilinear spinor operator product involves a double Wilson expansion in two different coordinate combinations. It is shown that in a gauge and scale invariant Weyl theory for a subcanonical spinor field of dimension $\frac{1}{2}$ the Wilson expansions can be explicitly constructed. No logarithmic-type modifications are necessary. The "dual" character of the expansions arises essentially from the exponentiation of logarithmic terms which is enforced by the gauge exponential. The nonlinear field equation arises naturally as a consistency condition. Explicit solutions for the generators in terms of the spinor field can be given. In the present framework these solutions are still not unique. (auth)

20194 CAUSALITY, LORENTZ INVARIANCE AND (i) THE ELECTROMAGNETIC INTERACTION OF A MASSIVE SPIN-ONE VECTOR FIELD WITH ARBITRARY MAGNETIC-DIPOLE MOMENT, (ii) THE MASSIVE YANG-MILLS FIELD. Jenkins, J. D. (Univ. of Durham, Eng.). Lett. Nuovo Cim.; 7: No. 13, 559-562 (28 Jul 1973).

Two theories are considered in the study of the causal nature of the propagation of higher-spin classical fields in external potentials: the electromagnetic interaction of a massive spin-one vector field with arbitrary magnetic-dipole moment; and the massive Yang-Mills theory with arbitrary compact, semi-simple gauge group. It is shown that these theories are consistent with the conjecture that a relativistic classical field theory is causal if and only if the corresponding canonically quantized theory is Lorentz invariant. (LBS)

20195 SOME REMARKS ON THE EXPONENTIAL SUPERPROPAGATOR. Houard, J. C.; Irac-Astaud, M. (College de France, Paris). Lett. Nuovo Cim.; 17: No. 12, 485-489(21 Jul 1973).

It is shown that the Lehmann–Pohlmeyer construction (Comm. Math. Phys., 20: 101(1971)) for the zero-mass superpropagator does not correspond to a limiting process, and essentially rests on the use of a suitable decomposition of the exponential. A natural generalization of the L–P decomposition is exhibited, and the connection of this generalization with the analytic regularization is pointed out. (LBS)

Quantum Field Theories

Refer also to abstracts 19432, 19517, 19559, 19628, 19665, 20194, and 20224.

20196 (IC-72/21) POSSIBLE ORIGIN OF FINITE QUANTUM ELECTRODYNAMICS FROM WEAK INTERACTIONS. Budini, P.; Furlan, P. (International Centre for Theoretical Physics, Trieste (Italy)). Mar 1972. 10p. INIS.

Based on previous work where a method for regularizing quantum electrodynamics with the use of nonpolynomial lagrangians has been given, an explicit form of the interaction lagrangian in quantum electrodynamics is proposed. Photons are considered as massless vector bound states of lepton–antilepton pairs interacting via exchange of neutrino loops. The electric charge, despite originating from weak interactions, is supposed not to depend on the Fermi constant G_f but to be determined by fundamental geometrical and scale symmetries. A hypothesis is expressed on the role of the muons in restoring parity conservation in passing from weak to electromagnetic interactions. (auth)

20197 (ORO-3992-120) METHOD OF CHARACTERISTICS AND CAUSALITY OF FIELD PROPAGATION. Mathews, P. M.; Seetharaman, M. (Texas Univ., Austin. Center for Particle Theory). Feb 1973. Contract AT(40-1)-3992. 7p. (CPT-174). Dep. NTIS $3.00.

It is pointed out that the method of characteristics gives only a necessary condition (not a sufficient one) for causality of field propagation. It is shown that the usual theory of vector fields with anomalous magnetic moment coupling to an external magnetic field is noncausal, contrary to what has been believed, as one of its modes of propagation turns out to be tachyonic, with the velocity of light as minimum velocity. (auth)

20198 RELATIVITY IN THE MATERIAL WORLD AND GENERALISED LORENTZ EQUATION. Kar, K. C.; Bhattacharyya, A. K. (Inst. of Theoretical Physics, Calcutta). Indian J. Theor. Phys.; 21: No. 1, 1-14(Mar 1973).

It is well known that Einstein's relativity is applicable only to vacuum. The theory of relativity in a medium at rest was developed by taking velocity of light in the medium as the fundamental velocity. Lorentz's electromagnetic equation as modified for the medium and Maxwell's other electromagnetic equations for this medium were shown to be relativistically invariant, with the help of newly derived transformation relations. The Lorentz equation in vacuum was derived by a new method. By this method modified Lorentz equations in nonconducting and conducting media were also obtained. The invariance of Lorentz modified equation in nonconducting medium was shown. The generalized Lorentz equation in a conducting medium is not invariant since the energy is not conserved in this case. (auth)

20199 NONUNIQUENESS OF CANONICAL FIELD QUANTIZATION IN RIEMANNIAN SPACE-TIME. Fulling, Stephen A. (University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201). Phys. Rev. D 7: No. 10, 2850-2862 (15 May 1973).

We point out and discuss an ambiguity which arises in the quantum theory of fields when the background metric is not explicitly Minkowskian—in other words, when an external gravitational field, real or apparent, is present. A general theory of a canonical neutral scalar field in a static universe, including the construction of a Fock space, is presented. It is applied to a portion of two-dimensional flat space-time equipped with a non-Cartesian space-time coordinate system with respect to which the metric is nonetheless static. The resulting particle interpretation of the field is shown to be different from the standard one in special-relativistic free-field theory. The ambiguity frustrates an attempt to define uniquely the energy-momentum tensor by the usual method of normal ordering. We discuss various suggestions for (1) distinguishing a unique correct quantization in a given physical situation, or (2) reinterpreting seemingly inequivalent theories as physically equivalent. In passing it is shown that the vacuum state and the energy density of a free field in a box with periodic boundary conditions differ from those associated with a region of the same size in infinite space; this result should be of interest outside the gravitational context. (auth)

20200 PERTURBATIVE CALCULATIONS OF SYMMETRY BREAKING. Weinberg, Steven (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 7: No. 10, 2887-2910 (15 May 1973).

The one-loop contributions to fermion and pseudo-Goldstone masses are calculated for the general class of renormalizable gauge theories. It is shown explicitly that when the masses are subject to any type of zeroth-order symmetry relation for all values of the parameters in the Largrangian, the divergences in the one-loop corrections to these symmetry relations cancel. The finite parts of these corrections are evaluated and discussed. Other topics considered include the connection of this work with that of Coleman and E. Weinberg, the constraints obeyed by scalar coupling constants, and the path-integral derivation of the Feynman rules for general renormalizable gauge theories. (auth)

20201 NONLINEAR CHIRAL SYMMETRY AND PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT—BOGOLIUBOV-PARASIUK-HEPP-ZIMMERMANN RENORMALIZATION. Lam, Yuk-Ming P. (Institut für Theoretische Physik der Freien Universität Berlin, Berlin, Germany). Phys. Rev. D 7: No. 10, 2950-2956 (15 May 1973).

The Bogoliubov-Parasiuk-Hepp-Zimmerman (BPHZ) renormalization is employed to study nonlinear chiral Langrangian field theories. It is shown how to construct Lagangians which, when renormalized by the BPHZ scheme, have the following properties: (1) current-algebra Ward-Takahashi identities are valid, and (2) either partial conservation of axial-vector current is sastisfied or the symmetry-breaking part of Langrangian belongs to the $(3,3^*) \oplus (3^*,3)$ representation of SU(3) × SU(3) or to the (1/2,1/2) representation of SU(2) × SU(2). (auth)

20202 EQUIVALENCE THEOREM ON BOGOLIUBOV-PARASIUK-HEPP-ZIMMERMANN BPHZ-RENORMALIZED LAGRANGIAN FIELD THEORIES. Lam, Yuk-Ming P. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15213). Phys. Rev. D 7: No. 10, 2943-2949 (15 May 1973).

The equivalence theorem for Bogoliubov-Parasiuk-Hepp-Zimmermann -renormalized Lagrangian field theories is proved by means of Feynman graphs. The transformation of Green's functions under a transformation of the Lagrangian vertex is also derived. (auth)

20203 CALLAN-SYMANZIK EQUATIONS AND ϵ EXPANSIONS. Mitter, P. K. (Center for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. D 7: No. 10, 2927-2942 (15 May 1973).

We analyze a noncanonically renormalized ϕ^4 theory in $4 - \epsilon$ dimensions with the aid of normal-product methods. By a systematic use of a Callan-Symanzik equations we show how a critical point can be determined and the anomalous scale dimensions of all composite operators obtained by using Wilson's ϵ expansion. These methods are also applied to the coefficient distributions appearing in operator-product expansions. (auth)

20204 QUANTUM FIELD-THEORY MODELS IN LESS THAN 4 DIMENSIONS. Wilson, Kenneth G. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14850). Phys. Rev. D 7: No. 10, 2911-2926 (15 May 1973).

The scalar $\lambda_0\phi^4$ interaction and the Fermi interaction $G_0(\bar{\Psi}\Psi)^4$ are studied for space-time dimension d between 2 and 4. An unconventional coupling-constant renormalization is used: $\lambda_0 = u_0\Lambda^\epsilon$ ($\epsilon = 4-d$) and $G_0 = g_0\Lambda^{2-d}$, with u_0 and g_0 held fixed as the cutoff $\Lambda \to \infty$. The theories can be solved in two limits: (1) the limit $N \to \infty$ where ϕ and Ψ are fields with N components, and (2) the limit of small ϵ, as a power series in ϵ. Both theories exhibit scale invariance with anomalous dimensions in the zero-mass limit. For small ϵ, the fields ϕ, ϕ^2, and $\phi\nabla_{a1}\cdots\nabla_{an}\phi$ all have anomalous dimensions, except for the stress-energy tensor. These anomalous dimensions are calculated through order ϵ^2; they are remarkably close to canonical except for ϕ^2. The $(\bar{\Psi}\Psi)^2$ interaction is studied only for large N; for small ϵ it generates a weakly interacting composite boson. Both the ϕ^4 and $(\bar{\Psi}\Psi)^2$ theories are solved here reduce to trivial free-field theories for $\epsilon \to 0$. This paper is motivated by previous work in classical statistical mechanics by Stanley (the $N \to \infty$ limit) and by Fisher and Wilson (the ϵ expansion). (auth)

20205 SUPERPROPAGATOR FOR A NONPOLYNOMIAL FIELD. Biswas, S. N.; Malik, G. P. (Department of Physics and Astrophysics, University of Delhi, Delhi-7, India); Sudarshan, E. C. G. Phys. Rev. D 7: No. 10, 2884-2886 (15 May 1973).

By using a method originally due to Okubo we calculate the momentum-space superpropagator for a nonpolynomial field $U(x) = 1/[1+f\phi(x)]$ both for a massless and a massive neutral scalar $\phi(x)$ field. For the massless case we obtain a representation that resembles the weighted superposition of propagators for the exchange of a group of scalar fields $\phi(x)$ as is intuitively expected. The exact equivalence of this representation with the propagator function which has been

obtained earlier through the use of the Fourier transform of a generalized function is established. For the massive case we determine the asymptotic form of the superpropagator. (auth)

20206 RELATIONS BETWEEN THE JOOS–WEINBERG AND TENSOR DESCRIPTION OF THE BOSON FIELDS. Gabos, Z.; Lazar, J. Stud. Univ. Babes-Bolyai, Ser. Phys.; 18: No. 1, 3-11 (1973). (In German).

It is proposed that for bosons with a spin s and with a rest mass different from zero, there exist linear relations between tensor wave functions and functions of the Joos–Weinberg type. Concrete expressions are given for coefficients which appeared in these relations. (tr-auth)

20207 HIGHER ORDER INFINITY REGULARIZATIONS IN GRAVITY-MODIFIED QUANTUM ELECTRODYNAMICS. Parveen, S. (Univ. of Karachi, Pakistan). J. Phys., A (London); 6: No. 7, 999-1010(Jul 1973).

The fermion self-mass is computed to order e^4 in gravity-modified quantum electrodynamics. It is found that regularization does proceed as one would expect from the results of second order computations given by Abdus-Salam, Isham and Strathdee (Phys. Rev.; D. 3: 1805 (1971)). The inverse of the gravitational constant which appears as an inbuilt cut-off regularizes the infinite terms $(e^2 \ln \infty)^2$ and $e^4 \ln \infty$, respectively, to $(e^2 \ln 1/\kappa m)^2$ and $e^4 \ln 1/\kappa m$. (auth)

20208 NEUTRAL SCALAR FIELD THEORY WITH A POINT SOURCE. Nagamachi, S.; Mugibayashi, N. (Kobe Univ., Japan). Progr. Theor. Phys. (Kyoto); 49: No. 1, 329-340(Jan 1973).

The theory of neutral scalar field in interaction with a point source is studied exhaustively in the light of the algebraic formulation of quantum field theory. Emphases are laid on observing again the case of an extended source from the present viewpoint, and exhibiting the equivalence of two definitions of the renormalized Hilbert space by GNS construction and by infinite tensor product. (auth)

20209 SPINOR SPACE REPRESENTATION OF LORENTZ GROUP. Srivastava, P. P. (Cenro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 19: No. 10, 267-306(1973).

The spinor space representation of homogeneous Lorentz group offered by Clifford numbers in Minkowski space is reviewed. Two spinor calculus naturally follows when spinor matrix representation for these numbers is used. Representations of the improper four group are also discussed. (auth)

20210 RESTRICTED LORENTZ TRANSFORMATIONS AS AN IMPLICATION OF THE PRINCIPLE OF EQUIVALENCE. Dutta, M. (Univ., Calcutta). Indian J. Phys.; 47: No. 1, 1-10(Jan 1973).

It is shown that the Lorentz transformation is almost deducible from the principle of equivalence. The basic postulates, mathematical and physical, are formulated clearly. (auth)

Gravitation and General Relativity

Refer also to abstracts 19323, 19608, 19628, 19632, 19699, 19705, and 20207.

20211 STRUCTURE OF THE TOMIMATSU–SATO GRAVITATIONAL FIELD. Glass, Edward N. (Department of Physics, Trenton State College, Trenton, New Jersey 08625). Phys. Rev. D 7: No. 10, 3127-3130 (15 May 1973).

The new Tomimatsu–Sato solution is a stationary axisymmetric vacuum solution of the gravitational field equations which has been proposed as a possible external field for rotating stellar objects. The solution is a Petrov type–I rotating generalization of a static Weyl solution. It has the unusual feature of a naked singularity outside a Killing horizon. In this note, after the asymptotic flatness of the solution is demonstrated, the energy and angular momentum are calculated and found to be m and ma, respectively. The locations of the horizons, infinite red-shift surfaces, curvature singularities, and closed timelike lines are given. The Killing horizon is found to be nonregular, and thus cannot be identified as an event horizon contrary to the claim of Tomimatsu and Sato. (auth)

20212 NEW THEORY OF GRAVITY. Ni, Wei-Tou (California Institute of Technology, Pasadena, California 91109). Phys. Rev. D 7: No. 10, 2880-2883 (15 May 1973).

A new relativistic theory of gravity is presented. This theory agrees with all experiments to date. It is a metric theory; it is Lagrangian-based; and it possesses a preferred frame with conformally flat space slices. With an appropriate choice of certain adjustable functions and parameters and of the cosmological model, this theory possesses precisely the same post-Newtonian limit as general relativity. (auth)

20213 DISPERSION OF GRAVITATIONAL WAVES BY A COLLISIONLESS GAS. Chesters, Dennis (Physics Department, University of Utah, Salt Lake City, Utah 84112). Phys. Rev. D 7: No. 10, 2863-2868 (15 May 1973).

Gravitational waves in a hot collisionless gas do not propagate on null geodesics. Using the methods of plasma kinetic theory, we derive dispersion relations from a self-consistent, first-order perturbation expansion of Einstein's, Boltzmann's, and the geodesic "force" equations. The wave's interaction with the higher shear moments of the ensemble introduces new length scales into the dispersion relations, which can affect the familiar modes and allow new ones. For an isotropic photon gas, the strongest mode has the dispersion relation $\omega^2 \simeq c^2k^2 - 144\pi GP/5c^2$, where P is the gas pressure. Because the length scale $c^2/(GP)^{1/2}$ is very large (10^{30} cm for the 3°K cosmic radiation), this retarded wave is pratically indistinguishable from the vacuum solution. We also find some weak, novel effects, like collisionless amplification and evanescent wave modes, which are very sensitive to the particles' momentum distribution. (auth)

20214 MOTION OF PARTICLES IN EINSTEIN'S RELATIVISTIC FIELD THEORY. VII. CHARGED PARTICLES AND CONSERVATION LAWS. Johnson, Coates R. (Department of Physics and Astronomy, University of Georgia, Athens, Georgia). Phys. Rev. D 7: No. 10, 2838-2843 (15 May 1973).

In an earlier paper the author developed a new approximation method for finding the Lorentz-covariant equations of structure and motion of interacting particles represented by singularities in Einstein's theory of the nonsymmetric field. The new method is based on certain conservation laws found to exist in Einstein's theory. In the earlier paper by the author the new method for finding the equations of structure and motion was applied to the case of interacting neutral particles. In this paper the method is used to find, to lowest order, the equations of structure and motion of interacting charged particles. The amount of labor involved in finding these equations of structure and motion is considerably less than that involved in an older method developed by the author. (auth)

20215 MOTION OF PARTICLES IN EINSTEIN'S RELATIVISTIC FIELD THEORY. VI. CONSERVATION LAWS AND MOTION. Johnson, Coates R. (Department of Physics and Astronomy, University of Georgia, Athens, Georgia 30601). Phys. Rev. D 7: No. 10, 2825-2837 (15 May 1973).

In several earlier papers the author developed an approximation method for finding the Lorentz-covariant equations of structure and motion of interacting particles represented by singularities in Einstein's theory of the nonsymmetric field and in Einstein's theory of the gravitational field. In this paper the author presents a second method for finding these equations of structure and motion. This second method is based on certain conservation laws which are found to follow from Einstein's field equations. The first part of the paper reviews the older method in preparation for the second part of the paper, where the new method is developed. In the last part of the paper the new method is applied to the case of neutral particles interacting with each other. The amount of labor involved in finding the equations of structure and motion of particles is considerably reduced through the use of the conservation laws. The conservation laws are also expected to aid in the investigation of electromagnetic and gravitational radiation. (auth)

20216 RECIPROCAL STATIC SOLUTIONS OF EINSTEIN'S EQUATION FOR SPHERES OF FLUID. Roy, A. R.; Rao, J. R. (Indian Inst. of Tech., Kharagpur). Indian J. Pure Appl. Phys.; 10: No. 12, 845-849(Dec 1972).

R. C. Tolman (Phys. Rev.; 55: 364(1939)) has found a class of exact solutions of Einstein's equations for spheres of fluid. Another set of solutions, known as "reciprocal" solutions, was obtained for the same set of field equations, following H. A. Buchdahl (Quart. J. Math.; 5: 116(1954)). Three of these solutions were studied in detail. It was observed that the boundaries of the spheres for the "reciprocal" solutions are in each case equal to $2m - r_b$ where m and r_b respectively correspond to mass and boundary of the sphere, according to the solutions of Tolman. The other physical quantities such as pressure, density and mass of the sphere for the "reciprocal" distributions were also determined. (auth)

20217 PLANE GRAVITATIONAL WAVE: GLOBAL STRUCTURE, COMPLETENESS, STABLE CAUSALITY. Klekowska, J.; Osinovsky, M. E. (Inst. for Theoretical Physics, Kiev). Lett. Nuovo Cim.; 7: No. 14, 633-637(4 Aug 1973).

Symmetric space–times having the Petrov type N are considered. The space–time V with a given metric is discussed. It is shown that the singularities of this metric are connected with a bad choice of coordinates, and a global analysis is carried out which enables one to remove these singularities and to obtain a correct global expression for the metric of V. It is shown that V is stably causal. (JFP)

20218 OPTIMIZATION AND DATA ANALYSIS OF THE FRASCATI GRAVITATIONAL-WAVE DETECTOR. Bramanti, D.;

Maischberger, K.; Parkinson, D. (European Space Research Inst., Frascati, Italy). Lett. Nuovo Cim.; 7: No. 14, 665-670(4 Aug 1973).

The design and performance of the Frascati gravitational wave detector are described. Histograms of the energy and impulse function are shown, and the detector output for a class-II event is given. (JFP)

20219 STRUCTURE OF THE SOURCES OF WEYL-TYPE ELECTROVAC FIELDS IN GENERAL RELATIVITY. Gautreau, R. (Newark Coll. of Engineering, NJ); Hoffman, R. B. Nuovo Cim.; 16B: No. 1, 162-172(11 Jul 1973).

Weyl-type fields are those static electrovac solutions to the Einstein–Maxwell field equations for which the metric component g_{44} and the electrostatic potential ψ are related by $-g_{44} = 1 - 2c\psi + \psi^2$. The structure of the sources that produce Weyl-type fields is investigated. It is found that, if the Weyl relationship holds also inside these sources, then they are structured such that over the extent of the source the ratio of the total mass density to the charge density is equal to the constant c in the Weyl relationship. It is found that the total mass density is that function which, when integrated over the extent of the source, gives the Schwarzschild mass as seen at infinity. It is not equal to the proper mass density $-(\kappa/8\pi)\ M^{ij}_{,ij}$, but is equal to the proper mass density plus the binding energy density. (auth)

20220 SOME MINIMALLY CHARGED WEYL SPACE–TIMES. Voorhees, B. H. (Pars Coll., Teheran). Nuovo Cim.; 16B: No. 1, 240-250(11 Jul 1973).

The behavior of test Maxwell fields is studied near the singularity of a class of Weyl space-times. It is found that these fields become unbounded with the exception of an electric monopole field in a background Schwarzschild space-time. It is also found that the divergence of these fields is, with one exception, of such an order as to invalidate the test field assumption near the singular region. (auth)

20221 CRITIQUE OF THE GRAVITATIONAL RADIATION DAMPING EFFECTS CALCULATED BY KEITH. Frehland, E. (Univ., Konstanz, Ger.). Lett. Nuovo Cim.; 17: No. 12, 490-492(21 Jul 1973).

It is shown that Keith's calculation of the gravitational radiation damping effects of a spinning symmetrical rod or sphere is based on incorrect assumptions and hence the occurrence of the predicted effects cannot be expected. (LBS)

20222 ROTATIONALLY SYMMETRIC CLUSTERS WITH ZERO NET ANGULAR MOMENTUM. Teixeira, A. F. (Cenro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 19: No. 12, 319-326(1973).

Exact solutions of Einstein's field equations corresponding to rotationally symmetric clusters of particles with zero net angular momentum are obtained. The matter density ρ is finite at the axis of symmetry and tends to zero as $r \to \infty$; and $\rho = 0$ corresponds to flat metric. (auth)

20223 GRAVITATIONAL INTERACTION OF ZERO-MASS PARTICLES. Andreev, A. F. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 17: No. 8, 303-306(20 Apr 1973).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 17: No. 8, 424-428(20 Apr 1973).

It is shown that in a gravitational interaction of zero-mass particles the energy momentum of the system is altered during the collision, but returns to the initial value as a result of the entire collision. It is noted that in principle there can exist macroscopic bodies moving with the speed of light and having on the whole a zero rest mass. (auth)

20224 ELECTROMAGNETIC RADIATION IN THE GENERAL THEORY OF RELATIVITY. I. Razgorov, N. N. (Magadan State Pedagogical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 65-69(1973). (In Russian).

The possibility of an accurate solution for the Einstein-Maxwell equations was investigated for an isotropic electromagnetic field. Three groups of metric space forms were noted, in which such a solution was permissible. (tr-auth)

20225 LIE DERIVATIVE OVER A FIELD OF TETRAD VECTORS IN GENERAL RELATIVITY AND RODICHEV'S CONDITIONS. Razgovorov, N. N. (Magadan State Pedagogical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 110-112(1973). (In Russian).

Theoretical expressions are evolved from the Lie derivative which allow for the incompressibility of space, a vector of tetrads and other factors under the conditions of Rodichev. (KSW)

20226 CLASSIFICATION OF SOME SPHERICALLY SPACE–TIME METRICS. Foyster, J. M.; McIntosh, C. B. G. Bull. Aust. Math. Soc.; 8: No. 2, 187-190(1973).

It is shown that the Petrov-Plebański classification of the trace-free Ricci tensors of some spherically symmetric metrics is invariant, contrary to an assertion by Takeno and Kitamura concerning these metrics. (auth)

REACTOR TECHNOLOGY AND REGULATION

20227 (AECL-4450) FORCED CONVECTIVE HEAT TRANSFER TO SUPERHEATED STEAM IN ROD BUNDLES. Groeneveld, D. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1973. 78p. Dep. NTIS (U. S. Sales Only) $6.00. AECL $2.00.

Fuel bundles cooled by superheated steam tend to develop hot spots in the gaps between two subchannels. The apparent heat transfer coefficient, h (based on bulk coolant temperature) within the gap deteriorates with reducing gap width. For fuel bundles used in Canadian boiling water reactors this reduction in h from bundle average values is conservatively estimated to be 40%. A method of predicting average bundle h values and maximum cladding temperatures is described. Because of the absence of relevant superheated steam heat transfer data, and the inaccuracy of the heat transfer data and correlations used, the uncertainty in predicting maximum cladding temperatures is large. British studies for gas cooled reactors have shown that spectacular increases in h (up to 1000%) are possible by using finned fuel elements. (auth)

20228 (AECL-4508) AECL ANNUAL REPORT, 1972-1973. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 23 May 1973. 52p. Dep. NTIS (U.S. Sales Only) $4.75.

Activities of the AECL for the year ending March 31, 1973, are summarized. Section titles include: nuclear power, nuclear power development, radiation and radioisotopes, research, operation and administration, AECL and industry, AECL and the universities, international collaboration, Nelson River transmission facilities, and auditor general's report. (RWR)

20229 (INIS-mf-361) BIBLIOGRAPHY ON REACTOR WATER CHEMISTRY. Nagarathna, R. A. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). 1971. 77p. INIS.

One hundred fifty five references on reactor water chemistry are cited covering the period up to 1971. References are listed alphabetically by author. Abstracts are given for all the references. Author index and report number index are also given. (auth)

20230 JAHRBUCH DER ATOMWIRTSCHAFT 1973. (Annual Review of Atomic Industry 1973). Mueller, W. D.; Hossner, R. (eds.). Duesseldorf, Ger.; Handelsblatt Verlag (1973). 396p.

The first chapter discusses the status and future projections of nuclear power plants, process heat, nuclear propulsion for ships, plants with low or moderate power, isotope and radiation application, fuel market, and fuel elements. The second section contains a listing for all countries which contains information about power plants, reactors, nuclear propulsion systems, atomic programs, scientific policy, financing, costs, organization, radiation safety, nuclear explosions for peaceful applications, research, atomic law, and licensing. The third section comprises a compilation for all countries of data about nuclear power plants and reactors. Listed are date of contracting, site, owner, type, reactor producer, power in MW(e), beginning of commercial operation, and total electricity production in GWh until June 30, 1972. (HBG)

20231 CHOICE OF CUTTING METHODS OF METALS WHEN REPAIRING ATOMIC REACTORS. Yurchenko, Yu. F.; Muravyev, V. F.; Pyatunin, B. A.; Malyavin, B. G. At. Energ. (USSR); 34: 427(1973). (In Russian).

Basic conditions defining the choice of cutting methods are considered. Presented are comparative characteristics of three kinds of equipment (mechanical, plasma, and electro-contact) for achieving insertion in metal walls. The electro-contact method has a number of advantages over the other two, especially when work is to be performed under water. Also presented are technical characteristics of materials for tool manufacturing, data on tool wearing during exploitation, characteristics of erosion products, equipment schemes to accomplish the following operations by means of the electrocontact method: (1) nest of tubes cutting; (2) tubes cutting from inside; and (3) insertion of holes in unfixed parts. (auth)

Power Reactors, Non-Breeding, BWR-Type

Refer also to abstracts 18194, 20362, 20425, 20428, 20433-20446, 24051, 20452, 20459, 20473-20476, 20483, 20485, 20489, 20490, 20498, and 20516-20522.

20232 (EUR-5019) SQFRAN: COMPUTER PROGRAMME FOR A BWR CORE. Garcin, J.; Mastrangelo, V.; Paruccini, M.; Rinaldini, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jun 1973. 51p. (In French). Dep. NTIS (U. S. Sales Only) $4.75. EUR FB 70,-.

The computer program SQFRAN treats one and half spatial dimension and few energy groups problems; it uses the SQUIRREL program for the calculation of the one dimension power distribution in the axial and radial direction, alternatively, and the steady state version of the FRANCESCA program for the thermohydraulic calculation of the coolant channels. In the present version, the SQFRAN program does not calculate the coolant mass flow redistribution nor the fuel evolution. The practical utilization of the program for the calculation of a BWR fuel cycle would therefore require further developments in the present version however the program may be utilized for the calculation of the power distribution in a core where the burn-up distribution is given. (18 references) (auth)

20233 (JAERI-M-5084) RECORDS OF THE RADIATION CONTROL FOR JPDR-I. Saito, C.; Sasaki, Y.; Ogura, T.; Tamura, K.; Nomura, I. (Japan Atomic Energy Research Inst., Tokyo). Jan 1973. 60p. (In Japanese). NTIS (U. S. Sales Only).

JPDR-I had been operated by natural circulation of the coolant water for about six years since criticality on August 22, 1963. It was subsequently shutdown on September 1, 1969 to rebuild the reactor for forced circulation as JPDR-II. The experiences of radiation control for this JPDR-I, up to that time, are described. (auth)

20234 (KFK-1761) PRESSURE EQUALIZATION SYSTEM FOR FUEL RODS OF WATER COOLED REACTORS AND STEAM COOLED FAST BREEDERS. Out-of-Pile Investigations. Malang, S.; Mueller, S.; Thun, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Apr 1973. 32p. (In German). Dep. NTIS (U.S. Sales Only) $3.75.

A pressure equalization system has been developed for fuel rods of water cooled reactors and steam cooled fast breeders. The system makes possible an important reduction of mechanical stresses in the claddings. In boiling water and steam cooled breeder reactors, a complete equalization of the internal and external pressure can be achieved over the whole lifetime of the fuel rods. This prevents a creep collapsing of the cladding onto the fuel, and avoids any exchange between the coolant and fission gases in the case of small leak defects. Satisfactory operation of the system has been tested in out-of-pile tests. 9 references. (auth)

20235 (NEDC-10747) PLUTONIUM UTILIZATION IN BOILING WATER REACTORS. Phase II. Semi-Annual Report, July-December 1971. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Nov. 1972. 83p.

For Edison Electric Inst.

Big Rock Point irradiations of 230 fuel rods have continued to peak burnups of 23,700 MWd/t with no apparent problems. There have been no defects in any of the mixed-oxide rods produced for Big Rock Point. Nondestructive hot cell examinations were completed on two Big Rock Point rods that were shipped to Vallecitos Nuclear Center. Profilometry, visual, gamma scan, neutron radiograph, and pulsed eddy current measurements on the rods indicated that the annular pellets were in good condition, that diametral changes in cladding dimensions were less than 1 to 2 mils, and that there was no evidence of cladding collapse or densification of the rods containing 92 percent of theoretical density annular pellets. Some evidence of corrosion due to relatively thick surface deposits was found on the outside of the cladding. These two rods were prepared for subsequent planned severe ramp tests in the GETR to 18 kW/ft linear power. Designs were developed for use of the 48 modern fuel assembly fuel rods that had been fabricated for use in Vermont Yankee at other sites. Economic and optimization studies were continued to include study of the effects of larger annular pellet i.d., variations in the isotopic composition of the recycled plutonium, increased discharge burnup, and more than one Pu concentration in the Pu island. Significant potential improvements in the reference design were noted through use of these variables. Conclusions from the program indicate that the test irradiations are proceeding successfully with good performance, no failures, and peak burnups of 26,000 MWd/MT; the interchangeable plutonium recycle bundle design objective has been accomplished with acceptable performance, economics, and safety; the annular fuel pellet concept continued to show promise as the most economical design for plutonium recycle in boiling water reactors; and there is considerable potential for improvement of plutonium values in the BWR through continued optimization. (auth)

20236 (RISO-M-1616) THREE-DIMENSIONAL BOILING-WATER REACTOR NEUTRON FLUX CALCULATIONS ON THE BASIS OF HOMOGENIZED FUEL BOX CROSS SECTIONS. Larsen, H. (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1973. 19p. Dep. NTIS (U. S. Sales Only) $3.00.

Three-dimensional overall calculations are set up with the SYNTRON/VOID program as whole core calculations on the Dresden 1 reactor. The utility of the methods used for the production of box average cross sections on the basis of separate fuel box calculations with the CDB code are investigated. An alternative method for the determination of box average diffusion constants is proposed. (auth)

20237 SWEDEN PINS HOPE ON NUCLEAR POWER. Jeffs, E. (ed.). Energy Int.; 10: No. 5, 20-3(May 1973).

Design characteristics for boiling water power reactors in Sweden are presented. (DCC)

20238 PILGRIM STATION OPERATING PROCEDURES. Baston, G. D. (Boston Edison Co., Plymouth, MA). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 2-3(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20239 PROCEDURES FOR NUCLEAR PLANT STARTUP AND OPERATION AT THE BRUNSWICK STEAM ELECTRIC PLANT. Stadler, D. C.; Waldorf, J. M.; Weatherwax, H. D. (Carolina Power and Light Co., Southport, NC). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 3(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20240 OPERATING PERFORMANCE OF THE LIQUID AND SOLID RADWASTE SYSTEM AT THE MONTICELLO NUCLEAR GENERATING PLANT. Eliason, L. R. (Northern States Power Co., Monticello, MN). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 6(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20241 OPERATING EXPERIENCE AT QUAD-CITIES NUCLEAR POWER STATION. Stephenson, B. B. (Commonwealth Edison Co., Cordowa, IL). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 11(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20242 BRUNSWICK NUCLEAR PLANT TRAINING PROGRAM. Connelly, J. G. Jr. (Carolina Power and Light Co., Raleigh, NC); Rowles, W. C. Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 21 (1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20243 ECCS EVALUATION FOR A BWR NUCLEAR POWER PLANT. Takahashi, S.; Masuda, F.; Suzuki, K.; Ono, K. (Tokyo Shibaura Electric Co.). Toshiba Rebyu; 28: No. 5, 513-516(May 1973). (In Japanese).

Very conservative assumptions are applied in evaluation of BWR ECCS (Emergency Core Cooling System) performance. These assumptions give us very severe results (very high fuel clad temperature during loss-of-coolant accidents (LOCA)) compared with real phenomena, though such severe results are acceptable for BWR. The conservative values are described. (auth)

20244 NUCLEAR POWER PLANT WITH PRESSURIZED- OR BOILING WATER REACTOR. Hannemann, F.; Schellhorm, L. (to Siemens AG). German Patent 1,551,251. 23 Jul 1970. Filed Date 20 Nov 1965. (In German).

A nuclear power plant with a pressurized- or boiling-water reactor and turboset working principally with wet steam is described. It is characterized by the fact that it is provided with reheating of the feedwater heater with live steam and a consecutive preheating of the feedwater with the condensate from the intermediate reheater. (TSS)

20245 784-MW STEAM TURBINE FOR UNIT NO. 3 OF FUKUSHIMA NUCLEAR POWER STATION. Tago, T.; Toda, A. (Tokyo Shibaura Electric Co. Ltd.). Toshiba Rebyu; 28: No. 5, 535-539(May 1973). (In Japanese).

A 784-MW, TC6F-1,500-rpm steam turbine is about to be supplied to Fukushima Nuclear Power Station of Tokyo Electric Power Co. for the third unit. This is one of the largest BWR turbines in Japan. As is usual with water reactors of the day, the initial pressure of the steam is as low as 950 psig; the turbine is, therefore, so designed as to accommodate the large volumes of flows at both the inlet and the exhaust, Together with other problems regarding nuclear power turbines, the design features of the main parts are described. A comparison is also made between this type of turbine and high-capacity fossil-fuel turbines. (auth)

20246 HVAC SYSTEM DESIGN FOR BWR POWER PLANTS. Kani, J.; Karai, K.; Taruishi, Y. (Tokyo Shibaura Electric Co. Ltd.). Toshiba Rebyu; 28: No. 5, 530-534(May 1973). (In Japanese).

Nuclear power plants should be so designed as to improve their operation reliability and also to limit radiation effects on both operators and site environments as low as possible. The HVAC (Heating, Ventilating and Air Conditioning) system is designed on the basis of these principal requirements and safety. The general principles and some special considerations of HVAC system design are described. (auth)

20247 APPLICATION OF HYBRID COMPUTER TO BWR DESIGN. Monta, K. (Nippon Atomic Industry Group Co. Ltd., Tokyo); Sueoka, Y.; Akira, T. Toshiba Rebyu; 28: No. 5, 546-550 (May 1973). (In Japanese).

An application of a hybrid computer to dynamic analysis of BWR power plants is described. Real-time simulation of a complete BWR power plant is achieved through appropriate partitioning of its model into the analog and the digital part of the hybrid computer. By the use of this simulator, extensive parametric studies of plant dynamics including various control systems can be performed easily and economically. (auth)

20248 EXPERIENCE WITH THE RECURRING INSPECTION OF NUCLEAR REACTOR STEEL PRESSURE VESSELS. Mazur, H. (Technischer Ueberwachungs-Verein eV, Hanover); Rumpf, H. G.; Tietze, A.; Werber, W.; Zutz, L. pp 102-109 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

In the Federal Republic of Germany steam boilers and pressure vessels of power plants are among the facilities requiring inspection during operation. For the past four years, the aim has been to incorporate recurring inspections in the planning of modern power reactors, and to apply the new techniques to the demonstration power plants Gundremmingen, Lingen and Obrigheim. Data is now available relating to the experience gained with recurring inspections of the reactor pressure vessels of these three plants. The essential experience gained during these inspections is summarized and conclusions are given regarding further developments in this field. The importance of technical safety is stressed. (auth)

20249 MECHANIZED EQUIPMENT FOR IN-SERVICE INSPECTION OF NUCLEAR REACTORS. Lautzenheiser, C. E. (Southwest Research Inst., San Antonio, TX). pp 205-220 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

Some of the mechanized equipment and techniques developed for the inspection of light water moderated PWR and BWR systems and of heavy water moderated BWR systems are described. Nozzle devices and vessel inspection devices are discussed, and other systems are considered. The current state of the art is reviewed, and a summary given of the position in January 1972. (auth)

20250 CONFERENCE ON REACTOR OPERATING EXPERIENCE, MYRTLE BEACH, SOUTH CAROLINA, AUGUST 5–8, 1973. Farmakes, R. (ed.) Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 1-31(1973). (CONF-730819-).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973).

Summaries of 39 papers are presented concerning reactor standards and procedures, waste management controls and problems, power reactor operating experience, research and test reactor operations, and personnel training and qualification. (DCC)

For abstracts of individual papers see: 18065, 18924, 20238–20242, 20256–20266, 20271, 20272, 20321–20326, 20349, 20350, 20373, and 20524–20533.

20251 DESIGN OF CONDENSER INTAKE STRUCTURE OF HAMAOKA NUCLEAR POWER PLANT. Watanabe, I.; Ioue, A. (Chubu Electric Power Co., Japan). Doboku Gakkaishi; 58: No. 2, 32-38(Feb 1973). (In Japanese).

The condenser intake structure of Hamaoka Nuclear Power Plant was successfully installed by adopting the pneumatic caisson works. The cooling water will be led to the plant through the structure and intake tunnel which is now under construction. It is the first attempt in Japan to collect cooling water by such an intake system. The outline of the design of the condenser intake structure is reported. (auth)

Power Reactors, Non-Breeding, PWR-Type

Refer also to abstracts 18232, 20244, 20248–20250, 20347, 20425, 20447–20450, 20453–20458, 20460–20472, 20477–20482, 20484, 20486–20488, 20491–20497, and 20499–20515.

20252 BIBLIS ELECTRONUCLEAR POWER PLANT (WEST GERMANY). Dieterich, L.; Wolf, M.; Vogel, J. (Rheinisch Westfaelisches Elektrizitaetswerk AG, Biblis, Ger.). Energ. Nucl. (Paris); 15: No. 1, 21-31(Jan 1973). (In French).

In May 1969 the first 1,200 MW(e) stage of an electronuclear power station at Biblis was started. A second stage almost identical to the first (1,300 MW(e)) was ordered in April 1971. Both stages are to be equipped with pressure–water reactors built to the Siemens formula. The installations are expected to come into operation in the spring of 1974 and autumn of 1976. (FR)

20253 NUCLEAR REACTOR VESSEL INSPECTION TOOL USING AN ULTRASONIC METHOD. Yamaguchi, T.; Fukushima, Y.; Kihara, S.; Endo, T.; Hoshida, Y. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). pp 1-9 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

An in-service inspection tool using an ultrasonic method for the PWR type reactor pressure vessel is under development and is described in outline. This equipment consists of the mechanical components of the tool, the control panel and data acquisition apparatus. The tool is designed to be adjustable to reactor vessels of various sizes. Fabrication of most parts of the tool are complete and a mock-up test to check the operation of the tool and the detectability of the defects is planned. (auth)

20254 IN-SERVICE INSPECTION TOOL FOR NUCLEAR REACTOR VESSELS. Keller, H. W.; Burns, D. C.; Murray, T. R. (Westinghouse Electric Corp., Pittsburgh). pp 126-139 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

A complete description is offered of the remote vessel inspection tool developed by Westinghouse to examine the areas required to be inspected under Section XI of the A.S.M.E. Boiler and Pressure Vessel Code. The design objectives, the selection of the tool concept, and also structural, mechanical, and electronic details are described. Operational facets, including shipping, storage, and assembly, are discussed. (auth)

20255 EQUIPMENT DESIGN TO MEET IN-SERVICE INSPECTION REQUIREMENTS. Katz, L. R. (Westinghouse Electric Corp., Pittsburgh). pp 151-157 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The Westinghouse pressurized water reactor complies with the requirements for accessibility and inspectability imposed by the ASME Code for in-service inspection of nuclear reactor coolant systems. This compliance is generally based upon plant arrangement and component design. A general arrangement drawing and a layout indicating the in-service inspection plan for each primary loop component is presented to describe the specific examination requirements and the method to be used for each examination to meet the requirements for a typical pressurized water reactor. The specific design changes which were implemented on the primary loop components to permit code compliance are also outlined. The current development programs and future plans for compliance are also described. (auth)

20256 WASTE HANDLING AT GINNA. Arthur, J. E. (Rochester Gas and Electric Corp., NY). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 5-6(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20257 RADIOACTIVE LIQUID EFFLUENTS FROM A LARGE PRESSURIZED WATER REACTOR. Harness, J. L.; Furr, B. J.; Tollison, A. C. Jr. (Carolina Power and Light Co., Hartsville, SC). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 6-7(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20258 H. B. ROBINSON UNIT NO. 2 OPERATING EXPERIENCE. Furr, B. J. (Carolina Power and Light Co., Hartsville, SC). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 10(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20259 CYCLE 1 FUEL PERFORMANCE AT H. B. ROBINSON UNIT NO. 2. Bohanan, C. S. (Carolina Power and Light Co., Raleigh, NC). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 10-11 (1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20260 MAINE-YANKEE STARTUP. Randazza, J. B. (Maine Yankee Atomic Power Co., Wiscasset, ME). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 11-21(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20261 REFUELING OPERATIONS AT H. B. ROBINSON. Hammond, J. (Carolina Power and Light Co., Hartsville, SC); Waters, D. B. Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 12 (1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20262 DEPENDENCE OF REACTIVITY UNIT CONVERSION ON REACTOR OPERATING CONDITIONS. Ball, R. M. (Babcock and Wilcox, Co., Lynchburg, VA). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 16-17(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20263 LOOSE-PARTS MONITORING SYSTEM DESIGN AND OPERATING EXPERIENCE. Fairburn, G. T. (Babcock and Wilcox Co., Lynchburg, VA); Brown, E. L.; Barr, T. Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 26(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20264 DAMPING OF XENON OSCILLATIONS IN THE MAINE-YANKEE REACTOR. Corcoran, W. R.; Humphries, J. R.; Litke, H. J.; LeBlanc, J. D. (Maine-Yankee Atomic Power Co., Wiscasset, ME). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 27-29 (1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20265 PACKAGING, TRANSPORT, AND DISPOSAL OF REACTOR SPENT RESINS IN BULK. Corbett, J. S. (Chem-Nuclear Systems, Inc., Bellevue, WA); Webster, B. H.; Beierle, F. Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 29(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20266 COMPARISON OF PREDICTED AND MEASURED RADIONUCLIDE CONCENTRATIONS IN MARINE ANIMALS NEAR AN OPERATING PWR. Pilmer, D. F.; Denovan, J. T. (Southern California Edison Co., Rosemead). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 29-30(1973).

From conference on reactor operating experiences; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20267 PRESTRESSED CONCRETE PRESSURE VESSEL FOR NUCLEAR REACTORS. Ziegler, A. (to Siemens AG). German Patent 1,614,447. 13 Aug 1970. Filed date 11 Mar 1967. (In German).

A pressure vessel of prestressed concrete for nuclear reactors is cooled by water under pressure. Parts of the prefabricated walls give a cylindrical form, characterized by the fact that the lower part is arranged to hold the coolant circulation pumps. (TSS)

20268 PRESTRESSED CONCRETE PRESSURE VESSEL FOR NUCLEAR REACTORS. Ziegler, A. (to Siemens AG). German Patent 1,614,449. 13 Aug 1970. Filed date 11 Mar 1967. (In German).

A prestressed concrete pressure vessel made from prefabricated units for pressurized-water nuclear reactors consists of lateral cylindrical walls that are led separately through the assemblage in place of fixing a vertical reservoir in the form of a cylindrical lid on a conical terminal unit. (TSS)

20269 PRESTRESSED CONCRETE PRESSURE VESSEL FOR NUCLEAR REACTORS. Ziegler, A. (to Siemens AG). German Patent 1,614,448. 13 Aug 1970. Filed date 11 Mar 1967. (In German).

A prestressed concrete pressure vessel made from prefabricated units for pressurized-water nuclear reactors consists of lateral cylindrical walls that are led separately through the assemblage in place of fixing a vertical reservoir in the form of a cylindrical lid on a conical terminal unit. (TSS)

Power Reactors, Non-Breeding, Graphite Moderated

Refer also to abstracts 18175–18178, 18181, 18182, 18184, 18191–18193, 18198, 18928, 18933, 20250, 20405, and 20414.

20270 (EURFNR-1085) EXPERIMENTS ON THE KINETICS OF OXYGEN TRANSPORT FROM OXIDE FUEL TO THE CLAD RELATED TO GCFR FUEL PINS. Bober, M.; Dorner, S.; Schumacher, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Sep 1972. 12p. (KFK-1756; CONF-720995-1). Dep. NTIS (U.S. Sales Only) $4.00.

From GCFR fuels and materials specialists meeting; Vienna, Austria (27 Sep 1972).

Work performed under United States–Euratom Fast Reactor Exchange Program.

The reaction of the oxygen of mixed fuels with the cladding material can be divided into three subsequent steps which correspond to three single processes in the solid and gaseous phases. Each of these steps can be a rate controlling process. Preliminary experiments which give an insight into the oxygen transport and estimate the rate controlling single process are described. The oxidation of the clad is rate controlling. Oxygen transport from $(U_{0.8}Pu_{0.2})O_{2-x}$ to the clad via the gas phase disappears at O/M ratios < 1.96. The diffusion coefficient of oxygen in hypostoichiometric uranium-20 mol % cerium-mixed oxide, which was used in the experiments, was estimated to be 2×10^{-8} cm^2/sec at 1,050°C. (auth)

20271 HTGR FUEL PERFORMANCE IN THE PEACH BOTTOM REACTOR. Turner, R. F.; Burnette, R. D.; Scheffel, W. J. (Gulf General Atomic, San Diego, CA). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 13(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20272 ANALYSES OF PEACH BOTTOM HTGR D1305 FUEL ELEMENT ACTIVITY PROFILES. Haire, M. J. (Gulf General Atomic, San Diego, CA); Zumwalt, L. R. (Gulf General Atomic, San Diego, CA). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 27(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20273 HARTLEPOOL DEMONSTRATES NEW TECHNIQUE DESPITE DESIGN HOLD-UP. Jeffs, E. Energy Int.; 10: No. 2, 10-12(Feb 1973).

Design characteristics and construction methods for the Hartlepool Reactor are presented. (DCC)

20274 HIGH-TEMPERATURE REACTORS, HELIUM-TURBINE ENGINES. Cautius, W. (Arbeitsgemeinschaft Versuchs-Reaktor GmbH, Duesseldorf). (1972). vp. (In German).

From joint meeting of VDE with VDI; Duesseldorf, Germany (17 Oct 1972).

The basic facts about the high temperature reactor are considered, and the primary conditions of the nuclear reactor (contamination by solid fission products) are investigated in order to operate a helium gas turbine plant safely and economically. The question of the allowed temperature of the fuel elements, the problem of leakage, and the questions of the gas turbine's operation are discussed. (GE)

20275 POLYVALENT NUCLEAR POWER PLANT. Maillet, E. (to Commissariat a l'Energie Atomique). French Patent 2,132,571. 9 Apr 1971. 9p. (In French).

A high temperature nuclear power plant is described. The primary circuit utilizes helium in a closed circuit for the cooling, a nuclear core as the heat source, a gas turbine for energy production, and an exchanger and a compressor attached to the axis of the gas turbine. The secondary circuit utilizes compressed air as the coolant; in addition it is provided with a system of air-air exchangers and at least one air or combustion gas turbine producing energy which is coupled to compressors attached to the same shaft. The plant is polyvalent. Besides the mechanical or electrical energy obtained from the turbine shaft, a large quantity of energy (which can be varied according to the demand) is available under conditions suitable for the desalination of sea water, urban heating, or utilization in the chemical industry. The variable power output of the plant renders it suitable for use as a peak power energy source. It is compact and its independence from water facilitates the choice of site. (FR)

20276 NUCLEAR REACTOR DESIGN. Tilliette, Z. (to Commissariat a l'Energie Atomique). French Patent 2,132,572. 9 Apr 1973. 9p. (In French).

A new conception in the design of nuclear reactors is presented which allows the power of the reactor and the pressure of the coolant to be increased. The essential feature of the design is the fact that the prestressed concrete pressure vessel encloses at its upper part a tank containing the core, and at its lower part vertical channels joined at their upper ends to the tank. These channels are regularly distributed about the vessel axis; the lower ends of these channels lead into the lower face of the tank. The prestressed concrete vessel is supported by structures which define an enclosure having a sufficient height to enable the dismantling of the elements contained in the vertical channels. The tank and vertical channels are equipped with a baffle system which defines a central hot gas current and a cold peripheral gas current. All the vertical channels are provided with energy producing modules, some of these channels being equipped with emergency modules. Each module can be constructed so as to contain exchangers and a blower. (FR)

20277 DEVELOPMENT OF HIGH-TEMPERATURE REACTORS IN THE FEDERAL REPUBLIC OF GERMANY. Part 2. The Introduction of the Pebble-Bed Reactor on the German Market and its Possible Advantages for the National Economy and Power Industry. Schwarz, D. Energ. Tech.; 25: No. 5, 125-128(1973). (In German).

High-temperature reactors with spherical and block-shaped fuel elements were previously compared in order to assess the technical advantages of one version or the other. These reactors are discussed from the economic point of view, considering the pebble-bed reactor in particular, and assessing to what extent these reactors will meet the growing long-term energy requirements. In a third article, cost-benefit analyses of the different HTR development lines will be given and compared with each other. (GE)

20278 COOLING SYSTEM FOR A REGULATING ELEMENT FOR A GUIDE TUBE IN A STEAM- OR GAS-COOLED REACTOR. Grundnann, M. (to Licentia Patent Verwaltungs GmbH). German Patent 1,803,067. 27 May 1970. Filed date 15 Oct 1968. (In German).

A cooling system for a regulating element for a guide tube of a reactor cooled by gas or vapor or the core of the reactor cooled by vapor in an ascending current of air is characterized by the fact that a double-walled guide tube coming out of the reactor under pressure on the internal side. The external wall of the guide tube is provided, at its base, with an opening for the entrance of cooling fluid into an annular chamber which is closed at its upper part on the other side of the internal wall. Means of outflow from the internal tube are provided for the fluid which cools the regulating elements in a descending current. (TSS)

Power Reactors, Non-Breeding, Otherwise Moderated

Refer also to abstracts 18401, 20249, 20367, and 20424.

20279 (AECL-4520) CANADIAN FUEL PERFORMANCE. Robertson, J. A. L.; Page, R. D.; Bodie, L. L. (Atomic Energy of Canada Ltd., Chalk River Nuclear Labs.). May 1973. 15p. (CONF-730611-13). Dep. NTIS (U. S. Sales Only) $3.00.

From 19th annual meeting of the American Nuclear Society; Chicago, Illinois, USA (10 Jun 1973).

Of 45,000 UO_2-in-Zircaloy fuel assemblies already irradiated in nine CANDU power reactors (totaling 2840 MW(e) net), over 99.5% have performed as designed. The few that developed leaks were simply discharged from the reactors by the fuelling machines. Fuel performance in the NPD and Douglas Point reactors is reviewed. Comparable experience with the newer Pickering and Gentilly reactors is described. (7 references) (auth)

20280 (AEEW-R-808) REACTOR PHYSICS MEASUREMENTS ON THE WINFRITH STEAM GENERATING HEAVY WATER REACTOR. Fox, W. N. (Atomic Energy Establishment, Winfrith (England)). Aug 1972. 51p. Dep. NTIS (U. S. Sales Only) $4.75. UK £1.00.

Reactor physics measurements made on the Winfrith SGHWR power station during its first four years of operation are surveyed and comparisons made with the predictions of performance models similar to those developed for commercial reactor design. (auth)

20281 IN-CORE APPLICATIONS AND EXPERIENCE WITH THERMOCOUPLES IN THE HALDEN BOILING WATER REACTOR. Aarset, B.; Kjaerheim, G. (OECD, Halden, Norway). pp 1889-1902 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From 5th symposium on temperature: Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

In the Halden reactor thermocouples have been used since 1962 in some 140 instrumented fuel assemblies for various purposes: coolant temperatures, fuel cladding and fuel surface and center temperatures, dryout indication, and as part of gamma and neutron thermometer designs. Early corrosion studies led to the choice of Inconel as cladding material for all in-core cables. Except for fuel thermocouples, all thermocouples have been made from 1 mm outer diameter cables with Chromel/Alumel wires in alumina insulation, and with hot junctions insulated from the sheath. Sheathed Chromel/Alumel thermocouples with a 0.5 mm outer diameter have been located in a fuel pellet close to the surface and successfully used for fuel temperature studies. Refractory metal thermocouples are used for fuel center temperature measurements. Insulation is MgO, BeO, or ThO_2, and sheaths are made from molybdenum or tantalum. Tantalum has been found to react with fuel and cladding in certain cases. Hot junctions have been made by welding or mechanical means and insulated or earthed. Cold junctions are located at the end of the fuel pin close to coolant temperature. Differential thermal expansion of insulation and thermocouple wires has caused mechanical problems. High electric conductivity of insulation materials causes difficulties at temperatures beyond 1800 to 2000°C. However, useful measurements have been made beyond these temperatures. (auth)

20282 IN-SERVICE INSPECTION SYSTEM FOR THE FIRST ARGENTINE ATOMIC POWER PLANT. Baez, J. N.; Venturino, C.; Wortman, O. (Comision Nacional de Energia Atomica, Buenos Aires). pp 97-101 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The in-service inspection system to be used at the Atucha nuclear power plant is described. The scanning device, transducers, inspection technique, and data acquisition system are outlined and general characteristics discussed. (auth)

Power Reactors, Breeding

Refer also to abstracts 20234, 20314, 20327, 20331, 20346, 20359, 20372, and 20416.

20283 (AEC-tr-7431) PROBLEMS OF SODIUM REMOVAL AND DEACTIVATION OF FAST REACTOR CIRCUITS AND COMPONENTS. Arkhipov, V. M.; Ivanenko, V. N.; Tymosh, B. S.; Shirin, V. M. 1973. Translation of Nekotoryye Voprosy Otmyvki ot Natriya i Oborudovaniya Konturov Reaktorov na Bystrykh Neytronakh. 10p. Dep. NTIS $4.00.

A study was made of some problems of the technological process of nonradioactive and radioactive sodium removal and the deactivation of the components of liquid metal systems with fast reactors. In the investigation, primarily the experience in operating the BR-5 reactor and the sodium test units of the FEI (Physics and Power Engineering Institute) is used. (auth)

20284 (ANL-8013) APPLICATION OF A GAS-CHROMATOGRAPHIC TECHNIQUE FOR NEON-23 DISCRIMINATION IN THE DETECTION OF FUEL-ELEMENT FAILURES. Panek, A. F.; McPheeters, C. C.; Wolson, R. D.; Meyer, R. J.; Kessie, R. W. (Argonne National Lab., Ill.). May 1973. Contract W-31-109-eng-38. 17p. AT $4.00.

A gas-chromatographic device has been developed which separated neon from xenon to eliminate ^{23}Ne interference in the radioactive assay of gaseous fission products. A column 8 ft-long by $^{3}/_{16}$-in. OD, vacuum-packed with 50-80 mesh Porapak Q, gave satisfactory separation at flow rates of 100 ml/min or greater with sample sizes up to 100 ml. Investigations indicated that a decontamination factor (DF) as high as 10^5 between neon and xenon is achievable with this system. (auth)

20285 (ANL-RDP-7) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JULY 1972. (Argonne National Lab., Ill.). 29 Aug 1972. Contract W-31-109-eng-38. 168p. AT $7.60.

Highlights of project activities for July 1972 are summarized. The EBR-2 operations and testing are reported. Operation of the Hot Fuel Examination Facility is reviewed. The development of FFTF instrumentation is summarized. Sodium impurity analysis and liquid sodium effects on stainless steels are presented. Studies of LMFBR fuels and materials, fuel cycles, physics, and safety are described. Performance testing of stainless steel clad PuO_2-UO_2 fuel elements is reviewed. (DCC)

20286 (ANL-RDP-16) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, APRIL-MAY 1973. (Argonne National Lab., Ill.). 9 Jul 1973. Contract W-31-109-eng-38. 245p. AT.

Highlights of project activities for April and May 1973 are summarized. The EBR-2 maintenance and modification program are reported. Operation of the Hot Fuel Examination Facility is reviewed. The development of EBR-2 instrumentation is summarized. Sodium impurity analysis and liquid sodium effects on stainless steels are presented. Studies of LMFBR fuels and materials, fuel cycles, physics, and safety are described. Performance testing of stainless steel clad PuO_2-UO_2 fuel elements is reviewed. Thermal effluent dispersion measurements for the Point Beach Power Reactor Unit 1 are presented. (DCC)

20287 (CONF-710922-) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON FAST REACTORS, AIX-EN-PROVENCE, SEPTEMBER 2-4, 1971. (Commissariat a l'Energie Atomique, Paris (France); American Nuclear Society, Hinsdale, Ill.). 1971. 158p.

Papers and discussions are presented on the following subjects; basic problems in fast breeder reactor development; gas cooled fast breeder reactors; fast reactor safety; fast reactor operating experience; experiences in fast breeder reactor construction. (JWR)

20288 (EURFNR-1090) INVESTIGATION OF THE PLANE OF RADIAL CONSTRAINT AS A PROBLEM IN FAST SODIUM-COOLED REACTOR CORE CLAMPING STRUCTURES. Class, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institute fuer Reaktorentwicklung). Mar 1973. 74p. (KFK-1769). Dep. NTIS $5.75.

Work performed under United States-Euratom Fast Reactor Exchange Program.

The occurrence of structural material swelling in fast sodium-cooled breeder reactors requires a specific core clamping system. The levels on which the hexagonal fuel element wrapper tubes support each other through spacers are termed planes of radial constraint. Some possible analytical models are discussed in order to describe the performance of the planes of radial constraint. Starting from a simplified annular model of the plane of radial constraint, an experiment is proposed which allows evaluation of the system. A comparison is made between the annular model and the spoke model of the plane of radial constraint. Some problems associated with core constraint are discussed, taking SNR-300 as an example. It is shown that in the case of SNR-300, the problem of core constraint is less a problem of reactor safety than a problem relating to reactor operation. (GE)

20289 (HEDL-SA-556) FAST REACTOR FLUX-SPECTRAL CHARACTERIZATION. McElroy, W. N. (Hanford Engineering Development Lab., Richland, Wash.). 1973. Contract AT(45-1)-2170. 23p. (CONF-730910-3). Dep. NTIS $3.25.

From international conference on irradiation experimentation in fast reactors; Jackson Hole, Wyoming, USA (10 Sep 1973).

The status and requirements of fast reactor flux-spectral characterization for LMFBR fuels and materials development programs are reviewed. The methods of data reduction, error assignment, and associated nuclear parameters in current use by the Fast Reactor Materials Dosimetry Center at HEDL are discussed. Examples of flux-spectral characterization by the SAND-II multiple foil method are presented for EBR-II dosimetry tests and fuels and materials irradiations. 36 references. (auth)

20290 (HEDL-SA-558) INSTRUMENTED IRRADIATION OF LMFBR ABSORBER MATERIAL IN THE EBR-II INCOT FACILITY. Hildner, R. A.; Pitner, A. L. (Hanford Engineering Development Lab., Richland, Wash.). 1973. Contract AT(45-1)-2170. 12p. (CONF-730910-1). Dep. NTIS $3.00.

From international conference on irradiation experimentation in fast reactors; Jackson Hole, Wyoming, USA (10 Sep 1973).

An instrumented experiment containing boron carbide and europia is being irradiated in the EBR-II. Sample temperatures and gas release are being monitored continuously during irradiation. Data monitoring and recording functions are performed by the EBR-II Data Acquisition System (DAS) computer. (auth)

20291 (JAPFNR-108) PROGRESS OF SODIUM COOLED FAST BREEDER REACTOR DEVELOPMENT IN JAPAN. Tomabechi, K.; Horiuchi, S. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). May 1973. 18p. (PNC-N-241-27(1)). Dep. NTIS (U. S. Sales Only) $3.00.

Work performed under United States-Japanese Fast Reactor Exchange Program.

The progress of fast reactor development in Japan during the last 12 months can be summarized as follows: (1) The construction of the Experimental Fast Reactor, "JOYO," has progressed. Fabrication of fuel for the reactor was started at the Tokai Works of PNC. Construction of the Material Monitoring Facility was completed and the Fuel Monitoring Facility is under construction. A full scale mock up test of components such as a rotating plug, fuel handling machines, etc., has been carried out at the O-arai Engineering Center of PNC and no serious trouble was

experienced with the test. Similar tests will be continued on these components simulating reactor operation. Analysis of various characteristics of the reactor and development of computer codes for reactor operation are being continued. Preparation for the commissioning tests for the reactor was started. Study on the Mark II core for "JOYO" has been continued. (2) The second conceptual design for "MONJU" was completed. Following the design, the third conceptual design was started and it is expected to be completed in a few weeks. Preparation for the review on "MONJU" program, which will be given by the government, is under way. Tests on some important parts of major components for "MONJU", such as seals for rotating plug, etc., were carried out. Fabrication of a prototype fuel handling machine, control rod drive mechanism, etc., is being made and facilities for testing those components are being installed. Relevant to the development of the steam generators for "MONJU", sodium water reaction experiments and operation of a 1 MW steam generator have been continued. Construction of a 50 MW steam generator test facility is progressing and it is expected to be in operation next spring. A prospective site for "MONJU" is under serious consideration. (auth)

20292 (JAPFNR-110) PRESENT STATUS OF RESEARCH AND DEVELOPMENT ON THE SODIUM TECHNOLOGY. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). May 1973. 60p. (PNC-N-241-73-27(3)). Dep. NTIS (U. S. Sales Only) $5.00.

Work performed under United States–Japanese Fast Reactor Exchange Program.

Research progress in materials testing in sodium environments, sodium chemistry, hydraulics studies in sodium loops, and components testing is briefly summarized. Most of the research was directed toward materials and components for the JOYO and MONJU reactors. (JWR)

20293 (JAPFNR-114) FUEL AND MATERIALS IRRADIATION TEST PROGRAM AND POST IRRADIATION EXAMINATION FACILITIES IN PNC. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Apr 1973. 30p. (PNC-N-241-73-27(7)). Dep. NTIS (U. S. Sales Only) $3.50.

The irradiation test programs in support of the JOYO and MONJU reactor development are briefly summarized. (JWR)

20294 (JAPFNR-115) PRESENT STATUS OF THE RESEARCH AND DEVELOPMENT ON THE FBR INSTRUMENTATION. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). May 1973. 5p. (PNC-N-241-73-27(8)). Dep. NTIS (U. S. Sales Only) $3.00.

Work performed under United States–Japanese Fast Reactor Exchange Program.

Research progress in the development and testing of instrumentation for sodium cooled fast breeder reactors is briefly reported. The instrumentation includes neutron detectors, failed element monitors, and process instrumentation. (JWR)

20295 (ORNL-TM-4089) HIGH-TEMPERATURE STRUCTURAL DESIGN METHODS FOR LMFBR COMPONENTS. Progress Report, October 1972–March 1973. Greenstreet, W. L.; Corum, J. M.; Pugh, C. E. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 264p. AT.

Work in the following areas is reported: elastic–plastic behavior; time-dependent behavior (uniaxial and multiaxial creep); development, evaluation, and distribution of structural analysis methods and tools (elastic–plastic creep analysis and computer programs); inelastic structural tests; material investigations; effect of biaxiality in creep-fatigue at elevated temperatures; analytical ratchetting studies; and design criteria for core structural components. Extensive data are reported for Type 304 stainless steel. (DLC)

20296 (ORNL-TM-4284) FAST REACTOR EXPERIMENTAL SHIELDING MONTHLY PROGRESS REPORT FOR MAY 1973. 189a No. 10028, Activity No. 40 01 03 1. Clifford, C. E.; Muckenthaler, F. J.; Stevens, P. N.; Freestone, R. M. Jr. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 76p. AT $5.45.

The accomplishments of the ORNL Neutron Physics Division in Fast Reactor Experimental Shielding Research during May are described. The Westinghouse and General Electric demonstration plant shielding experiments were essentially completed. The two-parameter hydrogen counter system is described and results compared with earlier single parameter hydrogen counter data. Additional hydrogen counter measurements were made for comparison with NE-213 results. Uranium foil data are also presented for the Westinghouse radial shield configuration. Some additional measurements designed to improve procedures for determining the background were obtained for the FTR gamma-ray experiments. These latter results differed from earlier measurements by about 20 percent. (auth)

20297 (RCN-183) FAST REACTOR PROGRAMME. Fourth Quarter 1972 Progress Report. Hoekstra, E. K. (comp.) Reactor Centrum Nederland, Petten). Feb 1973. 93p. Dep. NTIS (U. S. Sales Only) $6.75.

Results are given of spectrum and fission product reactivity worth measurements performed in the STEK reactor core 3000. A post-irradiation examination of fuel pin R54-F22A after failure at a canning temperature of 975°C and internal pressure of 52 bar maintained for 230 minutes is reviewed; initial results of the fifth loss-of-cooling experiment R63-LO5 are described. Progress on lattice parameter, phase diagram and temperature gradient studies on U(C,N) and preparation of uranium carbides are reported. A distillation method has been tried out as part of the analysis of impurities in sodium. A research programme on the influence of neutron radiation on the mechanical properties of the austenitic steel 1.4948 to be used in the SNR-300 reactor vessel is in the process of being set up. The effects of condensing of water, carbon tetrachloride and Freon 113 vapors on the stability of aerosols are reported. In the field of heat transfer in sodium, single-phase experiments in a four-rod bundle and planned two-phase experiments in 12- and 28-rod bundles with relevant heater development are described; a comparison is given between the results of heat transfer experiments in air performed on the roughened rods LUCY-104 and -107 and those performed on the smooth rod LUCY-102; flow velocity and wall shear stress data calculated with the one-dimensional code CACES: TAU and the two-dimensional code CACES: VESPRI are compared. (auth)

20298 (RCN-187) FAST REACTOR PROGRAMME. First Quarter 1973 Progress Report. Hoekstra, E. K. (comp.). (Reactor Centrum Nederland, Petten). May 1973. 79p. Dep. NTIS (U.S. Sales Only) $6.00.

Results are given of spectrum and fission product reactivity worth measurements performed in the STEK reactor core 2000. Post-irradiation examination of the failed fuel pin R54-F23A after in-pile burst testing at a canning temperature of 1000°C and internal pressure of 41 bar maintained for 7 hours is reviewed; initial results of the loss-of-cooling experiments R63-L06 and -L07 and post-irradiation examination of fuel pin L04 are described. Progress on lattice parameter, phase diagram, thermodynamic property and vapour pressure studies on U(C,N) and the preparation of UNF are reported. Determination of neutron radiation effects on the mechanical properties of the German steel 1.4948, to be used in the SNR-300 reactor tank, is described. The distillation method developed in connection with the analysis of impurities in sodium appears to work well. Following a study on nine liquid/gas systems, that of water/air appears to correctly simulate an Na/N_2 atmosphere in the SNR containment under hypothetical accident conditions. In the field of heat transfer in sodium, single-phase experiments in a four-rod bundle and planned two-phase experiments in 12- and 28-rod bundles are reviewed; results of heat transfer experiments in air performed on the roughened rods LUCY-107 and -108 are given; two methods of analysis to predict the thermohydraulic performance of a fuel element under single-phase flow conditions are described. 23 references. (auth)

20299 (WARD-CR-3045-2) CORE RESTRAINT DEVELOPMENT. Quarterly Progress Report for Period Ending May 31, 1973. French, J. W. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). Jul 1973. Contract AT(11-1)-3045. 25p. AT $4.00.

The alignment of the 12 radial restraint assemblies for the core restraint test facility is described. The load/deflection measurements for stainless steel and carbon steel fuel assembly duct models are presented. (DCC)

20300 (WARD-HT-3045-1) VALIDATION OF HIGH TEMPERATURE DESIGN METHODS AND CRITERIA. Quarterly Progress Report for Period Ending February 28, 1973. Bishop, E. C. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1973. Contract AT(11-1)-3045. 76p. AT $5.45.

The tensile properties of Type 304 stainless steel structures which represent LMFBR core components are measured. Design parameters and results of structural testing of the Multiloading Test Facility are presented. Thermal stress analysis for the FTR intermediate heat exchanger inlet nozzle is included. (DCC)

20301 IN-VESSEL HEAT EXCHANGER NUCLEAR REACTOR. Ventre, E. (to Electricite de France). French Patent 2,134,074. 5 Aug 1970. 11p. (In French).

A special type of in-vessel heat exchanger (for fast sodium cooled reactors) is presented. A number of cores are positioned in a ring around the supporting area. A fuel handling device is mounted above one of the cores, heat exchangers being suspended above the other cores. A central column fixed to the core sup-

porting area traverses the entire enclosure. This column is connected outside the enclosure to a system controlling its axial rotation and thus the position of the cores by successively displacing them from their normal operating positions beneath the exchanger to a recharging position beneath the handling device. The only hot point of the reactor is the space between the core and the heat exchanger (a space which can be very small). In addition, for the recharging of the fuel elements, it is sufficient to shut down the reactor during the time necessary for the rotation of the cores from one position to another (this time duration is extremely small). The coolant liquid flow rates can be regulated differently depending upon whether the core is in an operating or in a recharging position. No sliding or rotating joints between the pumps, cores and exchangers are necessary. (FR)

20302 HEAT EXCHANGER MODULE. Pouderoux, P. (to Societe Stein Industrie). French Patent 2,124,067. 6 Mar 1970. 7p. (In French).

A tubular type heat exchanger module is described. The module can be used by itself, but in preference forms part of a large multimodule heat exchanger. It is particularly suitable for the heat exchangers used for the vapor generators of fast neutron sodium cooled reactors. The module is provided with tubes for the circulation of a first fluid between two tubular plates contained in an envelope in which a second fluid circulates. At one end of the array, the tubes present a rectilinear part followed by elbow bend which act as expansion loops to compensate the differential expansion. In the rectilinear part near to the end, the tubes are arranged according to two square turn configuration networks displaced from one another by ½ a turn. (FR)

20303 NUCLEAR REACTOR. Sauvage, M. (to Commissariat a l'Energie Atomique). French Patent 2,133,530. 16 Apr 1971. 7p. (In French).

A nuclear reactor is described. The core of this reactor is composed of fissile or fertile matter elements and is cooled by circulating liquid metal (usually sodium). A special characteristic of the liquid sodium cooling system together with a simple vessel construction ensures a better protection of the reactor enclosure against accidental over-pressurization (especially in the case of an explosion in the reactor core). The reactor core is mounted inside a vertical axis cylindrical primary vessel provided with transverse channels near its lower end for the evacuation of the hot liquid sodium after it has traversed the core in the direction of the heat exchangers. The primary vessel is surrounded by an outer secondary vessel containing the exchangers. The cold sodium from the exchangers is re-circulated by the pumps and sent to the lower part of the reactor core. (FR)

20304 SAFETY COOLING FOR A SODIUM COOLED REACTOR CORE. Ernst, H. (to Licentia Patent Verwaltungs GmbH). German Patent 1,937,627. 4 Feb 1971. Filed date 24 Jul 1969. (In German).

The cooling is characterized by the fact that above the core there is produced a mixture of two phases by mixing with an additional product, which is inert with respect to sodium and separable from the sodium. (TSS)

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Refer also to abstracts 18292, 18756, 20250, 20285, 20286, 20289, 20298, 20300, 20344, 20366, 20410, 20411, and 20429–20432.

20305 (AAEC/TM-613) APPLICATION OF THE PULSED NEUTRON TECHNIQUE TO FAST METAL SYSTEMS. Moo, S. P.; Rainbow, M. T.; Ritchie, A. I. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1973. 31p. Dep. NTIS (U.S. Sales Only) $3.75.

The experimental apparatus and techniques which have been developed up to the end of 1971 at the AAEC Research Establishment at Lucas Heights to allow pulsed experiments to be performed in fast metal systems are described. The details of a metallic thorium assembly, the pulsed neutron source, timing systems and shielding and room return problems are discussed. 6 references. (auth)

20306 (CONF-730916-2) NON-LINEAR CREEP FATIGUE ANALYSIS OF A SODIUM HEAT EXCHANGER COMPONENT FOR THE FAST FLUX TEST FACILITY. Gangadharan, A. C.; Pai, D. H.; Berman, I. (Foster Wheeler Corp., Livingston, N. J.). 1972. 29p. Dep. NTIS $3.50.

From international conference on creep and fatigue in elevated temperature applications; Philadelphia, Pennsylvania, USA (23 Sep 1973).

The intermediate heat exchanger (IHX) for the fast flux test facility (FFTF) is a counter-flow shell and tube type exchanger which transfers heat from the radioactive primary sodium flowing on the shell side to the secondary sodium flowing inside the tubes. The structural material used in the IHX is 304 austenitic stainless steel. The required service life of the unit is 20 years, during which the plant is expected to operate at full power for about 15 years (131,400 hours) at a maximum temperature of 1050°F. It is postulated that some 800 operating transients will occur during the service life of the plant. The analysis of non-linear creep fatigue resulting from these transients is presented. 9 references. (auth)

20307 (CONF-730918-1) DESIGN OF THE INTERMEDIATE HEAT EXCHANGER FOR THE MAIN COOLANT LOOP OF THE FFTF. Wolowodiuk, W.; Dawson, B. E. (Foster Wheeler Corp., Livingston, N. J.). [nd]. 21p. Dep. NTIS $3.25.

From joint power generation conference; New Orleans, Louisiana, USA (16 Sep 1973).

The general mechanical design of the sodium-to-sodium intermediate heat exchanger for the Fast Flux Test Facility is described. This shell and tube type exchanger is 78⅜ inches in diameter by 35 feet long. The flow paths of the primary and secondary sodium are traced with particular attention to the devices that will assure uniform flow patterns. Specific design features which were developed for this heat exchanger are described. (auth)

20308 (COO–3019-4) SEMIANNUAL PROGRESS REPORT, SEPTEMBER 1–DECEMBER 31, 1972. Underhill, D. W.; Hall, R. R.; Gold, A.; Goldin, A.; First, M. W.; Moeller, D. W. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.). Feb 1973. Contract AT(11-1)-3019. 53p. Dep. NTIS $4.75.

Deposits of sodium and sodium oxide aerosol particles on heat exchanger surfaces following a molten sodium release within a closed loop cell of the FFTF can represent a serious resistance to heat flow. The magnitude of the added heat flow resistance is dependent upon the thickness of the deposit and its heat transfer coefficient. The latter value is influenced principally by the bulk density of the deposit. Bulk density measurements of sodium oxides generated in less than 2% O_2 atmospheres and deposited inside ducts dynamically, indicate that the sodium oxide layer contains mostly gas trapped in a very porous solid. Heat transfer coefficient measurements confirm that the deposited layer has heat transfer characteristics that are similar to a stagnant layer of nitrogen gas of equal thickness. The fission gas holdup beds for the FFTF will also remove ^{41}Ar from the argon cover gas. The efficiency of the removal of ^{41}Ar depends, among other factors, on the adsorption capacity of the charcoal in the holdup beds. The adsorption coefficients of argon on Pittsburgh PCB charcoal at temperatures from –76°C to –140°C and pressures from 5 to 140 psig were determined experimentally. These adsorption coefficients increased with decrease in temperature, as expected. However, the increase in adsorption with pressure was much less than one-to-one, especially at the lower temperatures. Thus, a three-fold increase in pressure at –75°C resulted in only a 50% increase in the adsorption coefficient, and a six-fold increase in pressure at –140°C resulted in only a 20% increase in adsorption coefficient. These measurements, when plotted as a function of the Polanyi potential, were in good agreement with data in the literature for adsorption at subatmospheric pressures. These new results permit the effect of pressure on the adsorption of krypton from an argon carrier gas to be analyzed as a function of the quantity of adsorbed argon and explain the strong effect that the pressure of the argon carrier gas has on the adsorption of krypton at low temperatures. From the standpoint of reactor safety these new data permit one to 1) calculate the removal of ^{41}Ar in the holdup beds and 2) determine the effect of argon adsorption on the holdup of krypton and xenon. The chemical composition of sodium aerosol particles depends upon the oxygen content of the atmosphere enclosing the molten metal. Sodium peroxide is formed in normal atmospheres, sodium monoxide in low oxygen atmospheres, and sodium metal in inert atmospheres. Oxide mixtures occur as the initial oxygen content of the atmosphere is consumed by reactions. Reactions also take place between sodium and the other normal constituents of the atmosphere, i.e., water vapor and carbon dioxide. A method is described to determine the chemical composition of aerosol particles formed in nitrogen atmospheres containing less than 10% air. (auth)

20309 (HEDL-SA–548) EBR-II DOSIMETRY TESTS. Jackson, J. L.; Kellogg, L. S.; McElroy, W. N.; Ulseth, J. A. (Hanford Engineering Development Lab., Richland, Wash.). 1972. Contract AT(45-1)-2170. 23p. (CONF-730910–2). Dep. NTIS $3.00.

From international conference on irradiation experimentation in fast reactors; Jackson Hole, Wyoming, USA (10 Sep 1973).

The test description and results are presented for the HEDL analysis of the reactor run 50H test, which represents the most recent large-scale, high-power measurements of the EBR-2 neutron environment. 22 references. (auth)

20310 (HEDL-SA-573) INDUSTRIAL DEVELOPMENT OF THE NUCLEAR FUEL SYSTEM FOR THE FAST TEST REACTOR. A Systems Study. Burgess, C. A. (Hanford Engineering Development Lab., Richland, Wash.). May 1973. Contract AT(45-1)-2170. 210p. Dep. NTIS $12.50.

Thesis. Submitted to Washington Univ.

Several important characteristics of the management used in an applied research and development program conducted to provide the manufacturing technology for a nuclear fuel system are examined. An awareness of the planning and implementation techniques that have been applied is discussed. A descriptive case history and analysis of the management system leading to the production of the first commercially produced nuclear fuel for the Fast Test Reactor are presented. The program included the laboratory development of a reference process to manufacture the nuclear fuel to a product specification and a concurrent industrial program leading to commercial production. The development of the product specifications was further supplemented by laboratory parametric studies to evaluate process interaction and its effect on product characteristics. The use of this interaction analysis to support the initiation of the industrial applications is shown. The industrial program was initiated by an information meeting for potential industrial participants which also solicited industrial input to aid in the overall program formulation. The analysis of this input served as a reference point for the overall program. The use of various budgeting and scheduling techniques is examined. Methods including Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) have been applied with varying degrees of success. The current use of CPM, combined with Time Bar graphs, is presented as the most successful for this program. The management system is analyzed in the perspective of a systems model, and some of the implementation techniques used are presented. This systems application offers management a tool to assure a more optimum performance of the organization or organizations involved. (auth)

20311 (HEDL-SA-577) IRRADIATION TEST CAPABILITIES OF THE FFTF. Schively, D. P. (Hanford Engineering Development Lab., Richland, Wash.). 1973. 45p. (CONF-730910-4). Dep. NTIS $4.25.

From international conference on irradiation experimentation in fast reactors; Jackson Hole, Wyoming, USA (10 Sep 1973).

The Fast Flux Test Facility (FFTF) will be the primary irradiation test facility for the US LMFBR program. The central feature of the FFTF is the fast test reactor (FTR) which will provide a high-intensity, hard-spectrum, fast neutron flux for irradiation testing of fuels and materials to be used in future fast breeder power reactors. As many as eight core positions will be available for contact instrumented tests. These test positions present an ultimate capability of six installed closed loops, each with a thermal rating of 4.3 MW(t). The characteristics of the instrumented test positions are discussed together with the irradiation test vehicles which are being designed to utilize these positions. (auth)

20312 (HEDL-TME-73-43) SUBCRITICAL REACTIVITY SURVEILLANCE PROCEDURES FOR THE FAST FLUX TEST FACILITY. Fleischman, R. M.; Upton, J. W. Jr.; Bennett, R. A. (Hanford Engineering Development Lab., Richland, Wash.). May 1973. Contract AT(45-1)-2170. 69p. Dep. NTIS $5.45.

Current development efforts to formulate reliable subcritical reactivity measurement procedures for FFTF are described. Emphasis is placed on problems anticipated with the transfer of techniques developed in the zero power critical facility to high power conditions in FTR. Discussions of interfaces with existing FTR instrumentation and operating procedures are given. More detailed preliminary calculations of the steady-state and dynamic response of the FTR to reactivity changes in the source range are presented. (auth)

20313 (KFK-1572) KFKINR-SET OF GROUP CONSTANTS. Nuclear Data Basis and First Results of Its Application to the Recalculation of Fast Zero-Power Reactors. Kiefhaber, E. (comp.). (Kernforschungszentrum, Karlsruhe (West Germany). Institute fuer Neutronenphysik und Reaktortechnik). Mar 1972. 54p. INIS.

Using the MOXTOT-set, it was possible to predict the criticality of all zero-power reactor-assemblies studied as test cases within an uncertainty limit of ±2%. Further improvements of the MOXTOT-set have been necessary in order to reduce the uncertainty range from the criticality prediction and to improve the prediction of other important quantities, e.g., reaction rates. For the test of the improved set of group constants, named KFKINR-set, primarily the same critical assemblies as those chosen for the test of the MOXTOT-set have been used. The important changes in the group constants with respect to the MOXTOT-set, concern mainly ^{239}Pu, ^{238}U, ^{235}U, and ^{240}Pu. For the determination of the group constants for the elastic down-scattering, the collision density of a typical sodium-cooled fast reactor, namely that of the SNR, has been used as the weighting spectrum. The complete nuclear data basis of the improved group constants is described. First results for the recalculation of fast critical assemblies are presented. Some essential characteristics of the new set of group constants and the results obtained are summarized. (INIS)

20314 (LA-UR-73-740) QUALITY ASSURANCE PLAN FOR MIXED OXIDE FUEL FOR LMFBR. Zeigler, R. K. (Los Alamos Scientific Lab., N. Mex.). 1973. 7p. (CONF-730911-1). Dep. NTIS $3.00.

From Western regional conference of American Society for Quality Control; Portland, Oregon, USA (27 Sep 1973).

An evaluation of the adequacy of the methods of analysis is presented for chemical specifications of LMFBR/FFTF mixed uranium-plutonium oxide fuel. This evaluation is based on statistical analyses of the results obtained by seven laboratories on a distributed batch of FFTF fuel pellets and distributed special blends of certain impurities and a high purity uranium-plutonium oxide matrix. Based upon the results of this evaluation a quality assurance program will be discussed which will ensure the continuing existence of quality data for the chemical characterization of LMFBR/FFTF mixed oxide fuels. 4 references. (auth)

20315 (SC-RR-720879) PARAMETRIC INVESTIGATION OF ALL-METAL U-10 w/o Mo ANNULAR ASSEMBLIES. Coats, R. L. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 71p. Dep. NTIS $5.75.

The parameters governing fast pulse reactor performance are examined over a range of critical assembly dimensions using Monte Carlo techniques. Prompt neutron lifetime, critical dimensions, and spectra are obtained. Particular attention is paid to the region of system dimensions of interest for SPR III. 26 references. (auth)

20316 (SLA-73-5559) OPERATING EXPERIENCE WITH URANIUM-MOLYBDENUM FUEL IN PULSED REACTORS. Horak, J. A.; Reuscher, J. A.; Sasmor, D. J. (Sandia Labs., Albuquerque, N. Mex.). 1973. 25p. (CONF-730801-5). Dep. NTIS $3.25.

From symposium on materials performance in operating nuclear systems; Ames, Iowa, USA (28 Aug 1973).

Almost all fast pulsed reactors built since 1960 use a uranium-molybdenum alloy as the fuel. Two pulsed reactors utilize α phase U-Mo alloy and five use γ phase U-Mo alloy. All but VIPER are homogeneous all metal annular cylinders. All achieve prompt criticality by inserting fueled control rods and all are shut down by thermal expansion of the fuel; VIPER also uses the Doppler effect for shutdown. The operating experience obtained with U-Mo fuel in pulsed reactors is presented. The presentation is in ascending order of the operational temperature rise induced in the fuel per pulse. (auth)

20317 (WARD-2171-23) FTR FUEL MANAGEMENT STUDY. Barthold, W. P.; Calamai, G. J.; Schellin, S. A. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). 27 Aug 1971. Contract AT(45-1)-2171. 64p. AT $5.45.

Two basic fuel management schemes for the Fast Test Reactor (FTR) were analyzed. Both fuel management schemes were based upon batch removal of fuel assemblies at the end of each cycle. It was assumed that no fuel assemblies are shuffled, rotated or reinserted, and that the feed enrichment for all cases is equilibrium cycle feed enrichment. The first fuel management scheme used an approach where the fuel assemblies with the highest burnup are discharged to maximize the burnup for a cycle. Those fuel assemblies which would exceed the maximum allowable burnup during the following cycle must be replaced. If necessary, additional fuel assemblies are replaced to achieve the necessary excess reactivity for the following cycle. This refueling scheme has been referred to as "maximum burnup refueling." In the second approach, the discharged fuel is selected on the basis of scattering throughout the core. One-third of all assemblies which would exceed their burnup limit beyond three cycles, one-fourth of all assemblies which would exceed their burnup limit beyond four cycles, one-fifth of all assemblies which would exceed their burnup limit beyond five cycles, ..., are replaced. The goal of 45,000 MWD/T average discharge burnup can be met with a peak burnup of 74,000 MWD/T for scatter refueling. For maximum burnup refueling the goal of 45,000 MWD/T requires a peak burnup of 79,000 MWD/T. A slightly higher feed enrichment is required for the maximum burnup fuel management scheme. Although maximum burnup refueling maximizes the average discharge burnup for each cycle, scatter refueling assures a higher cumulative discharge burnup and achieves the same flux and power capability as maximum burnup refueling. Scatter refueling also provides a more uniform flux to the test positions in the core. (auth)

20318 (WARD-2171-36) FAST FLUX TEST FACILITY QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING FEBRUARY 28, 1973. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div). 1973. Contract AT(45-1)2171. 70p.

Research and development activities for the FFTF Reactor are presented under the following headings; reactor system design and engineering; shielding design and analysis; fuel assembly; reactor enclosure system; core support structure; in-vessel handling machine; reactor system engineering; heat transport system components and engineering; and plant control and data acquisition. (DCC)

20319 EXPERIENCE WITH TYPE K THERMOCOUPLES IN AN EXPERIMENTAL NUCLEAR REACTOR. Martin, C. D.; Gabbard, C. H. (Oak Ridge National Lab., TN). pp 1869-1874 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From 5th symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

Five years' operating experience with 1071 type K thermocouples in an experimental nuclear reactor is reported. The thermocouple junctions were fabricated at Oak Ridge National Laboratory from commercial sheathed thermocouple material purchased to rather stringent specifications. The thermocouples were calibrated before being installed in the reactor where they were constantly monitored through five years of operations. Many of the thermocouples accumulated more than 20,000 hours of operation above 485°C with numerous heating-cooling cycles which are well documented. Additionally, 278 of these thermocouples were monitored continuously by a digital computer-based data acquisition system. A technique was developed for using the computer to minimize scatter among thermocouples. Reliability, scatter, and long-term drift are discussed. (auth)

20320 GROOVED MELT WIRES FOR TEMPERATURE MEASUREMENT OF NUCLEAR FUEL. Salgado, P. G.; Thamer, B. J.; Rudman, R. L. (Los Alamos Scientific Lab., NM). pp 755-761 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 1. Preston-Thomas, H. (ed.). Pittsburgh; Instrument Society of America (1972).

From 5th symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P1).

Grooved melt wires were developed to measure temperature profiles in nuclear fuel along the length of the coolant channels of the UHTREX reactor. Connecting tubes or wires could not be used in this measurement. In this method fuel elements have been examined after testing to see which of an implanted array of various melt wires have melted, thus determining the temperature within limits at various locations. Work at the Los Alamos Scientific Laboratory has developed grooved melt wires of a variety of compositions covering the temperature range of 408 to 1923°K (275 to 3002°F). Melting can be determined easily and with good precision by radiographing the exposed fuel element or by removing the melt wires and examining them visually. The change in the right angle at the base of the groove in the melt wire is a sensitive indication of melting. An investigation of the effect of time on the shapes of a groove at a sub-melt temperature has indicated that one month is the minimum time for scratch smoothing to give an appearance of melting if the material of the wire is pure, unalloyed, and nonvolatile. (auth)

20321 PLANT AVAILABILITY IMPROVEMENTS FOR THE ADVANCED TEST REACTOR. Burdick, E. E.; Kaufman, N. C. (Aerojet Nuclear Co., Idaho Falls, ID). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 14(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20322 LIGHT-WATER INFILTRATION REACTIVITY EFFECTS IN THE AMES LABORATORY RESEARCH REACTOR (ALRR). Norman, J. H.; Hill, D. L. (Ames Lab., IA). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 14(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20323 DECOMMISSIONING THE BABCOCK AND WILCOX TEST REACTOR. Carson, J. F. (Babcock and Wilcox Co., Lynchburg, VA). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 15(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20324 PERFORMANCE TESTING OF A MIXED CORE UTILIZING TRIGA STANDARD AND TRIGA-FLIP FUEL. Randall, J. D.; Feltz, D. E.; Godsey, T.; Hardt, M. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 16(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20325 QUALITY ASSURANCE PROGRAM FOR THE DELIVERY AND OPERATION OF THE NORTH CAROLINA STATE UNIVERSITY PULSTAR REACTOR. Bohannon, J. R. Jr. (North Carolina State Univ., Raleigh). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 17-18(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20326 LOW-BUDGET TECHNIQUES FOR IN-PLANT PRODUCTION OF TECHNICAL VIDEO TAPES. Gurganus, E. K. (Ames Lab., IA). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 24-25(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20327 PREHEATING SODIUM PIPING AND MECHANICAL COMPONENTS FOR LMFBR. Fujimoto, J. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan); Nakamura, K.; Miyashita, T.; Ojiri, Y. Mitsubishi Juko Giho; 10: No. 3, 344-350(May 1973). (In Japanese).

The method of preheating by the electrical resistance heater (tubular type) is described. The results of the study indicate: heaters had no problem regarding heat and temperature when they were set up so as to remove the thermal stresses and used at the surface power density under 1 W/cm^2, and the fluid in the pipes had no effect on heat transfer. The study was made for JOYO (Japanese experimental LMFBR) and the data have been applied to it. (auth)

20328 WRE MAKES PRECISION ASSEMBLIES FOR LUCAS HEIGHTS. Alcock, J. R.; Munsberg, R. Australas. Mfg. Eng.; 22: No. 8, 11-15(Sep 1971).

The manufacture of an in-pile pressure vessel and an inner shield plug for the Hifar reactors from titanium-stabilized steel Type 321 is described. A general description of each assembly is given. (AT)

20329 PARTICULATE COLLECTION ON TWO NMC TYPE AIR FILTERS. Chabot, G. E.; Skrable, K. W.; Wedlick, H. L. (Lowell Technological Inst., MA). Health Phys.; 25: No. 2, 171-173(Aug 1973).

Two NMC type air filters were evaluated for use with monitors associated with a one megawatt swimming pool type research reactor and were found to display low collection efficiencies for the particles of interest i.e., those resulting from the release and decay of fission product gases and the naturally occurring progeny of ^{220}Rn and ^{222}Rn. A series technique was used for the evaluation. The attention of users of the NMC filters at nuclear installations, particularly where small particle sizes are involved, is drawn to the likely poor retention properties for such particulates. A redesign of the filter holders of the NMC constant air monitor to take alternative filter papers is suggested. (UK)

20330 STUDY OF THE SHIELDING PROBLEMS OF WATER COOLED-WATER MODERATED RESEARCH REACTORS. Boldyrev, G. N.; Veselkin, A. P.; Egorov, Yu. A.; Emel'yanov, I. Ya.; Zhirnov, A. D.; Orlov, Yu. V.; Konstantinov, L. V. Vop. Fiz. Zashch. Reaktorov; No. 5, 235-250(1972). (In Russian).

Several special installations were constructed to study shielding. The BSF and GTR installations are swimming pool reactors, employing 1 and 3 Mw neutrons, respectively, placed on moving bridges in large water pools. The B-2 device on the BR-5 reactor was developed to study the laws of the attenuation of γ-quanta and reactor neutrons in the geometry of a unidirectional beam. The materials to be studied or models of the shielding were placed in a niche in the reactor shielding. A zero-power reactor was intended for studying processes in the shield directly adjacent to the reactor core. The reactor was equipped with filters in one of the directions making it possible to obtain an optimal relationship between the neutron and γ-quanta fluxes. The OR-M experimental device is also intended for studying problems in reactor shielding. The 50-kW water-cooled moderated research reactor is also equipped with devices for conducting experiments on shielding. Various studies associated with the radiation problems of shielding are carried out on this reactor. A description of the reactors, experimental devices, and characteristics of the devices and methods used in the research are given. (J)

20331 HETEROGENEITY EFFECTS IN ZPPR ASSEMBLY 2: A PLUTONIUM-FUELED DEMONSTRATION FAST REACTOR STUDY. Davey, W. G.; Amundson, P. I.; Collins, P. J.; Palmer, R. G. (Argonne National Lab., Idaho Falls, ID). Nucl. Sci. Eng.; 51: No. 4, 415-440(Aug 1973).

An extensive series of measurements has been made in the Demonstration Reactor benchmark, the Zero Power Plutonium Reactor (ZPPR) Assembly 2, to provide physics data necessary for LMFBR design. An important objective of the ZPPR program was to test the applicability of data obtained in the plate-fueled critical to a power reactor design with a more homogeneous composition. Sufficient fuel inventory was obtained in the form of rods which were used, within sodium-filled calandria, to build large zones in

which direct comparisons of parameters could be made with those in the plate zones. A variety of quantities have been compared in the two environments. In addition to the direct reactivity worth of rod-for-plate substitution, comparisons are given for small sample and cell reactivity worths, neutron spectrum, reaction rate ratios, in-cell reaction rates, reaction rate scans, sodium-void coefficient, and ^{238}U Doppler coefficient. The experiments are compared with calculations using the ARC system and ENDFB/Version-I data. It is found that many parameters of interest can be adequately studied in the plate geometry and that the calculation methods, in general, give a good representation of the heterogeneity effects. Some areas are identified in which further experimental and analytical study is needed. (auth)

Production and Materials Testing and Processing Reactors

Refer also to abstract 18061.

20332 (DUN-7777-8) SYSTEM ACTION PLAN, SYSTEM NO. 08: CHEMICAL DECONTAMINATION. Kratzer, W. K. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 20 Dec 1971. Contract AT(45-1)-1857. 18p. Dep. NTIS $3.00.

The objective of the decontamination plan is to reduce the combined exposure-decontamination costs that will be incurred during the summer 1972 N Reactor maintenance outage and further reduce these costs during the subsequent year or years of operation. Scope of the work involves developing an external decontamination procedure, reducing the costs of the present internal decontamination procedure, and applying both procedures during the summer 1972 maintenance outage. (auth)

20333 (UNI-13-A) TEST CHANGE NO. 1: PT-N-336, N REACTOR ROD CALIBRATION. Larkin, D. L. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 10 Jul 1973. Contract AT(45-1)-1857. 5p. Dep. NTIS $3.00.

20334 (UNI-SA-1) N REACTOR FUEL ELEMENT IMPROVEMENT PROGRAM, A SYSTEMS APPROACH. Leitz, E. E. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 30 May 1973. 9p. (CONF-730811-3). Dep. NTIS $3.00.

From intersociety energy conversion conference; Philadelphia, Pennsylvania, USA (13 Aug 1973).

The Fuel Systems Analysis Task Force evaluation of the United Nuclear Industries' operations affecting fuel performance (fuel manufacturing, fuel handling, and fuel irradiation) is presented. The fuel performance during the fiscal year the Task Force's programs were being implemented improved very significantly. Although the data are too limited at this time to draw a final conclusion, it is estimated the fuel failure rate has been cut by at least a factor of two and very likely by a factor of 10. It is significant that no fuel elements have failed of those which were charged after implementation of the intermediate program during the Summer of 1972. 3 references. (auth)

20335 TEN YEARS OF IRRADIATION EXPERIMENTS IN BR-2. von der Hardt, P. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Atomwirt., Atomtech.; 18: No. 6, 285-286(1973). (In German).

Although comparable reactors exist, the BR-2 possesses particularly well arranged irradiation channels which together with the compact core offer favorable conditions for irradiation. The BR-2 is essentially used to capacity through two contracts: an agreement between Euratom and the CEN Mol, and a utilization contract between the German Gesellschaft fuer Kernforschung, Karlsruhe, and the CEN. More than half of the irradiation capacity is taken up by the two large German development programs on the fast breeder and the high temperature reactor. The ER-2 will be even more attractive as a material testing reactor after a power increase planned for 1974, and continuing full utilization can be expected at least for the next five years. (GE)

Propulsion and Package Reactors

Refer also to abstracts 18932 and 20415.

20336 (AI-AEC-13075) REACTOR ASSEMBLY 5-kwe REACTOR THERMOELECTRIC SYSTEM. Rood, H. (ed.) (Atomics International Div., Canoga Park, Calif. (USA)). 30 Jun 1973. Contract AT(04-3)-701. 154p. Dep. NTIS $9.75.

The reactor assembly engineering performed for the 5-kW(e) reactor is summarized. Areas pertaining to the reactor as a whole are emphasized such as the nuclear effects, plenum hydraulics and in-core coolant mixing, mechanical and structural design of the reactor, vessel design, and core assembly procedure. Also included is a discussion of reactor performance margins, and selected reactor layout drawings. (auth)

20337 (AI-AEC-13093) DESIGN AND ANALYSIS OF THE RADIATOR STRUCTURE FOR SPACE POWER SYSTEMS. Dauterman, W. H.; Montgomery, L. D. (Atomics International Div., Canoga Park, Calif. (USA)). 22 Jun 1973. Contract AT(04-3)-701. 257p. (NASA-CR-121222). Dep. NTIS $15.00.

The design, analysis, fabrication, and development of the 5-kW(e) radiator structure are shown. Thermal performance, meteoroid protection, structural capability during launch, development testing and space operation, material evaluation, and the configuration selection are described. The fin-tube development program depends on the relative values of the thermal coefficients of expansion. The initial selection of aluminum fins and Type 316 stainless-steel tubes was based on previous experience; however, the large differential in their expansion rates showed that an alternate, more compatible, combination was needed. Copper, stainless-steel-clad copper, boron-impregnated aluminum, and an independent radiator with a titanium structure were all considered as alternate materials. The final selection was Lockalloy fins with Type 304 stainless-steel "D" tubes. (auth)

20338 (NAA-SR-11884) PROGRESS REPORT SNAP AEROSPACE NUCLEAR SAFETY PROGRAM, JANUARY-MARCH 1966. Detterman, R. L. (Atomics International, Canoga Park, Calif.). 15 May 1966. Contract AT(11-1)-Gen-8. 57p. Dep. NTIS $5.00.

Declassified 17 Apr 1973.

Progress is reported on reentry and abort studies, reactor disintegration projects, fuel reentry burnup, fuel ablation and particle formation, reactor disposal projects, and reactor transient projects. (FS)

20339 CONTAINER SHIPS: OIL FUELED VERSUS NUCLEAR POWERED. An Economic Comparison. Dade, T. B.; Witzig, W. F. Engineering research bulletin B-109. University Park, PA; Pennsylvania State University (1973). 60p.

Innovations in the maritime industry to increase ship productivity, along with the sharp rise anticipated for the cost of fossil fuel, call for a reappraisal of marine nuclear propulsion to meet the high power requirements of modern container ships. A recently designed oil fueled, high speed, quick turnaround container ship was used as the base for a comparison to assess the economic feasibility of nuclear propulsion for ships of this type. To avoid inadvertent advantage to one or the other alternative, both were analyzed according to two independent economic criteria: average annual operating costs and average annual net profit. Each of these criteria accounts for the significant costs incurred by the ship over its life, including the effects of taxes and the time value of money. The results of sensitivity computations indicate that the nuclear powered container ship, as modified for this comparison, would now be competitive with the oil fueled ship on transatlantic routes. A similar ship specifically designed for nuclear propulsion should have an economic advantage. 32 references. (auth)

20340 HIGH TEMPERATURE CORE THERMOCOUPLE DEVELOPMENT FOR THE NUCLEAR ROCKET ENGINE PROGRAM (ROVER). Goodier, B. G.; Fries, R. J.; Tallman, C. R. (Los Alamos Scientific Lab., NM). pp 1959-1965 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From 5th symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

A molybdenum sheathed, W/W-26% Re thermocouple of superior characteristics, especially for a nuclear environment, has been developed and tested by the Los Alamos Scientific Laboratory. The design includes the following features: (1) Optimization of component dimensions as indicated by an analytical study of thermocouple output error due to the degradation of insulator resistivity with temperature; (2) High-purity BeO webless insulators to enhance the electrical resistance between the wires and to provide accommodation for longitudinal thermal-expansion differences; (3) Special fabrication techniques (including vacuum bakeout and dry-box assembly procedures) to ensure the purity and cleanliness of the internal components; (4) Sizing of radial clearances to minimize the temperature gradients resulting from γ-heating rates as high as 150 W/g; and (5) An internal thin-walled tantalum tube and an NbC coating on the bore of the graphite thermowell to reduce the rate of carbon migration into the insulator and wires. Reactor and furnace tests show that this thermocouple is accurate within 1 percent to 2300 K, can withstand 2200 K for periods exceeding 2 hours, and at least 50 cycles from 450 to 2050 K. (auth)

Reactor Safety and Environmental Aspects

Refer also to abstracts 18232, 18544, 20243, 20427, and 20525.

20341 (BNWL-SA-4734) TORNADO RESISTANT DESIGN. Anderson, T. L. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1973. 48 p. (CONF-730640-1). Dep. NTIS $4.50.

Generally, earthquakes and tornados are the two classes of extreme loads which must be considered in design of high-risk structures and equipment. In many instances tornadic effects are more severe than seismic loads and they often govern design of major portions of structures. However, unlike seismic analysis, there are no building code requirements governing tornado design. Tornadic effects include high winds, pressure differentials and tornado-generated missiles. These phenomena and the methods in current use for tornado-resistant design are described. Particular emphasis will be given to missiles and their damage potential. Examples will be drawn from recent designs where inelastic behavior is permitted and a degree of damage allowed. Areas of design uncertainty and recent trends in regulatory criteria as they affect the designer will be reviewed. (auth)

20342 (CONF-720469-(Vol. 1)) NUCLEAR CONTROVERSY IN THE USA. Proceedings of International Workship held at Lucerne, Switzerland, April 30-May 3, 1972. (Swiss Association for Atomic Energy, Bern; Atomic Industrial Forum, Inc., New York). 1972. 145p.

Information on the development of nuclear power plants in the U.S. is presented concerning public reaction to radiation and reactors; thermal effects; principal critics of nuclear power; environmental effects of nuclear power plants; power reactor safety; and positions of the AEC, a reactor manufacturer, and a utility company. (DCC)

20343 (CONF-730819-1) REVIEW OF 1972 SAFETY-RELATED OCCURRENCES IN NUCLEAR REACTOR POWER PLANTS. Scott, R. L. (Oak Ridge National Lab., Tenn.). [nd]. 21p. Dep. NTIS $3.25.

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973).

Six hundred forty four reports of incidents, failures, and design or construction deficiencies reported in 1972 by light water reactor central power stations were evaluated. Tables are presented summarizing the information. Included in the tables is the frequency of items reported with regard to components, systems, causes, specific deficiencies, and time of occurrence. Selected occurrences are discussed for those which occurred at PWRs, BWRs, and during construction. (auth)

20344 (HEDL-TME-72-109) EFFECTS OF MOLTEN FUEL MOVEMENT DURING A FAST REACTOR OVERPOWER TRANSIENT. Partain, W. L.; Waltar, A. E.; Culley, G. E.; Scott, J. H., Hanson, J. E. (Hanford Engineering Development Lab., Richland, Wash.). 4 Aug 1972. Contract AT(45-1)-2170. 68p. AT $5.45.

Fuel failure characteristics under transient conditions in the FFTF reactor were analyzed. The FFTF core was modeled in detail for core loadings representative of bounding conditions for most of the projected history of the core. A hypothetical core disruptive accident was analyzed using the MELT-IIA code. (JWR)

20345 (KFK-1702) NUCLEAR SAFETY: FIRST SEMIANNUAL REPORT, 1972. (Kernforschungszentrum, Karlsruhe (West Germany)). Dec 1972. 96p. (In German). Dep. NTIS (U.S. Sales Only).

Since January 1, 1972, all research programs concerning the safety of nuclear installations, with the exception of fast breeders, are combined under the "Project Nuclear Safety" of the nuclear research center Karlsruhe. The first semiannual report describes studies in the various fields of the project which comprise problems of emergency core cooling, especially the deformation of light water reactor fuel rods during and after the blowdown phase; core melting; development of filters for the separation of radioactive noble gases; dynamic stresses of safety devices; release of radioactive material during hypothetical severe accidents; decontamination procedures after accidents; criteria for emergency planning; and information systems for reactor safety. (HBG)

20346 (KFK-1794) INVESTIGATIONS ON THE FLOW AND TEMPERATURE DISTRIBUTION DOWNSTREAM OF LOCAL COOLANT BLOCKAGES IN ROD BUNDLE SUBASSEMBLIES. Kirsch, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). May 1973. 107p. (In German). Dep. NTIS (U.S. Sales Only) $7.50.

Thesis. Submitted to Technische Hochschule, Karlsruhe (West Germany).

Safety investigations for liquid-metal cooled fast breeder reactors (LMFBRs) include a possible propagation of a fault which could be initiated by a local coolant blockage arising from an accumulation of small particles at a spacer grid of a rod bundle subassembly. In order to evaluate the coolant temperature rise close to such blockages, flow and temperature distributions downstream of simulated local blockages have been investigated. Experiments determining the flow pattern show that a distinct recirculation zone with standing eddies develops downstream of an impermeable blockage. Whether in this recirculation zone local boiling is possible is given by experiments determining the dimensions of the recirculation zone and the mass exchange between this zone and the main flow. Knowing these values a mean coolant temperature, averaged for the volume of the recirculation zone, can be calculated. With the investigated blockages (obstructing up to 41% of the flow area) these mean coolant temperatures do not exceed the saturation temperature. Moreover, an analysis of the measurement method shows that these temperatures have to be considered as conservative, i.e. too high. Results of measurements from a water test rig and the sodium temperatures calculated from these results are given. 40 references. (auth)

20347 (WAPD-TM-999) FLASH-5: A FORTRAN IV PROGRAM FOR TRANSIENT SIMULATION OF A REACTOR PLANT WITH A DETAILED CORE. Murphy, J. H.; Redfield, J. A.; Davis, V. C. (Bettis Atomic Power Lab., Pittsburgh, PA). May 1973. Contract AT(11-1)-Gen-14. 51p. Dep. NTIS $4.75.

The FLASH-5 computer program, an extension of the previously published FLASH programs, simulates severe transients in a pressurized water reactor in which the variation of pressure is significant in both space and time. FLASH-5 allows up to 100 pressure-determining nodes within the reactor core, which can be used to represent up to 20 axially sectionalized core flow paths. The program is useful in evaluating loss-of-coolant accidents with emergency core cooling, power excursions with pressure generation and transmission, and parallel channel dynamics problems in which pressure variation is important. 10 references. (auth)

20348 (WASH-1250) SAFETY OF NUCLEAR POWER REACTORS (LIGHT WATER-COOLED) AND RELATED FACILITIES. (Atomic Energy Commission, Washington, D. C.). Jul 1973. 510p. TIC Free.

Chapters are included on descriptions of light water nuclear power plants and related facilities, basic philosophy and practices for assuring safety, the government's regulatory role, radioactive effluents, evaluations of postulated accidents, current approaches to the assessment of societal risks, the water-reactor safety research program, and selected topics in areas of special interest. Appendices include background material, information on the discharge of heat to the environment, and a discussion of public attitudes. (JWR)

20349 RADIOACTIVE WASTE MANAGEMENT: BASIS FOR NATIONAL DECISION MAKING. Roberts, I. C.; Bartlett, C. B. (Environmental Protection Agency, Rockville, MD). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 5(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20350 REVIEW OF 1972 SAFETY-RELATED OCCURRENCES IN NUCLEAR REACTOR POWER PLANTS. Scott, R. L. (Oak Ridge National Lab., TN). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 29(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20351 A REVIEW OF THE RESULTS AND PREDICTIONS CONTAINED IN THE WAERMELASTPLAN RHEIN. Hoffman, O. (Technische Ueberwachungsvereine, e.V., Cologne). Tech. Ueberwach.; 14: No. 5, 147-149(1973). (In German).

The temperature of the Rhine River will rise considerably in the near future if the nuclear power plants that are currently in the planning stage depend solely on river water cooling and if the cooling water will be taken from the Rhine. The predictions contained in the "Waermelastplan Rhein" which has been set up to determine the thermal regime of the river and to calculate its capacity to cope with the thermal load to be expected from the operation of the planned nuclear power plants clearly show that in some areas, the maximum permissible thermoload might be exceeded by the year 1975. Considering the present degree of pollution of the river, however, this might happen even earlier. The only alternative, therefore, is to provide all future nuclear power plants to be built along the Rhine with cooling towers. The results of the calculations are given in a table. (GE)

20352 REACTOR CONSTRUCTION: DIFFICULTIES IN THE UPPER RHINE AREA. Nucleus (Bonn); 19: No. 3, 30-31(1973). (In German).

The efforts made by France and Germany to ensure meeting their energy demands by constructing new nuclear power plants along the Rhine are described. The problems associated with cooling such plants are discussed, as this has become a critical issue due to the limited thermal capacity of the river, which in turn restricts the cooling water supply for these plants. It is feared that this will affect the development of Federal Lands in this area. (GE)

20353 NUCLEAR POWER ENGINEERING: EUROPEAN INTEGRATION AND CONSOLIDATION. Wiss., Wirt., Polit.; 3: No. 16, 3-9(1973). (In German).

Topics discussed at the Reactor Meeting 1972: Light-water reactor engineering, merchant ships with nuclear propulsion, high-temperature reactor engineering, fast breeder demonstration plants, uranium supply and related problems, and nuclear energy and the environment are briefly summarized. (GE)

20354 DEVELOPMENT OF IN-SERVICE INSPECTION SAFETY PHILOSOPHY FOR USA NUCLEAR POWER PLANTS. Bush, S. H. (Battelle Pacific Northwest Labs., Richland, WA); Maccary, R. R. pp 10-20 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From Conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The general safety philosophy that led to the development of the A.S.M.E. Section XI Code on "In-service inspection of nuclear reactor coolant systems" is described together with a general description of the code coverage. Significant features of the code are: the concept of designing the system to permit inspection and possible repairs; the requirement of a complete examination prior to start-up to serve as a base line for future examinations; the acceptance of new inspection systems or techniques more amenable to remote applications, provided such systems can be validated; and the establishment of inspection periods and level of inspection for given components or sections of components based on the concepts of relative probability of degradation of the various portions of the systems and the significance of such degradation to the safety of the reactor system. Some consideration is given to future revisions in the code and their significance to safety and to reactor operation. (auth)

20355 INTERNATIONAL REQUIREMENTS FOR THE PERIODIC INSPECTION OF PRESSURE VESSELS. Whenray, J. J. (British Standards Institution, Hempstead, Eng.). 200-204 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

A review is presented of the requirements for the periodic inspection of boilers, static and portable pressure vessels, and nuclear vessels, which are applied throughout the world. It covers the requirements for external and internal examination, and hydraulic tests. Also included is information on the manufacturer's responsibility, and inspection organizations. (auth)

Reactor Theory and Calculation

Refer also to abstracts 19995, 20232, 20262, 20313, 20398, and 20408.

20356 (ANL-7722) ARC SYSTEM CROSS-SECTION GENERATION CAPABILITIES, ARC-MC^2. Stenberg, C. G.; Lindeman, A. (Argonne National Lab., Ill.). Jun 1973. Contract W-31-109-eng-38. 594p. Dep. NTIS $13.60.

The documentation of the ARC System modules INPUT (CSI001), REXSEC (CSC001), SCSFM (CSC002), BCSFM (CSC003), XSEDIT (CSE001), and DELDATA (CSI007) is presented. CSI001 reads and processes all the BCD information supplied by the ARC System alphanumbric epithermal cross section input data set. CSC001 calculates cross sections in the resolved resonance region using Doppler-broadened line shapes with an equivalent relation to account for heterogeneities. CSC002 calculates cross sections from nonresonant quantities which are represented in the MC^2 library as coordinates of end points of linear segment data. CSC003 calculates broad group microscopic multigroup cross sections by a flux-weighted contraction of ultrafine and fine group cross sections. CSE001 edits selected isotopes designated by the user from the microscopic broad group cross section data set XS.ISO. CSI007 processes delayed neutron data and these data are added in the form of two additional files to the microscopic cross section data set XS.ISO. 18 references. (auth)

20357 (CONF-730648-(P1)) TRANSACTIONS OF 1973 ANNUAL MEETING OF THE ISRAEL NUCLEAR SOCIETY. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). 26 Jun 1973. 80p.

Sessions were presented on reactor theory, isotopes and radiation applications, and nuclear medicine. (JWR)

20358 (GA-7542(Vol.2)) GAF/GAR/GAND FAST REACTOR CROSS SECTION PREPARATION SYSTEM. Volume II. GAND2 and GFE2: Computer Programs for Preparing Input Data for the GAFGAR, GGC, and MICROX Codes from an ENDF/B Format Nuclear Data File. Archibald, R. J.; Mathews, D. R. (Gulf General Atomic Co., San Diego, Calif.). Mar 1973. Contract AT(04-3)-840. 267p. Dep. NTIS $15.50.

The GAND computer program was developed to prepare the cross section data needed by the GAFGAR code directly from a basic library of evaluated nuclear data in the ENDF/B format. The GAR data prepared by the GAND code may also be used in resonance cross section calculations in the GGC-5 and MICROX programs. The current version (GAND2) may also be used to prepare point cross section data for absorber nuclides for use in the thermal neutron sections of the GGC, GTF, and MICROX programs. The GFE2 specialization of the GAND2 program may be used to prepare fine-group averaged cross sections and scattering transfer matrices for use in the fast neutron sections of the GGC and MICROX programs. The GAND2 and GFE2 programs are operational on the UNIVAC-1108 computer using the EXEC-8 operating system. 54 references. (auth)

20359 (JAPFNR-109) PROGRESS OF THE FAST REACTOR PHYSICS PROGRAM. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). May 1973. 12p. (PNC-N-241-73-27(2)). Dep. NTIS (U. S. Sales Only) $3.00.

Work performed under United States-Japanese Fast Reactor Exchange Program.

Research progress in integral experiments and their analysis and the development of reactor constants and analysis methods is briefly summarized. The research was centered on mockup experiments and analyses for the JOYO and MONJU reactors. (JWR)

20360 (KFK-1778) INVESTIGATION OF CALCULATION OF THE DOPPLER COEFFICIENT OF FAST REACTORS. Siep, I. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Apr 1973. 132p. (In German). Dep. NTIS (U.S. Sales Only) $8.75.

Thesis. Submitted to Karlsruhe Univ. (West Germany).

A method is developed for the calculation of temperature-derivatives of effective group cross-sections in the resolved resonance region. By combination with the Karlsruhe code "DOP", which starts from statistical resonances, a program is obtained for direct calculation of dkeff/dT in the whole resonance region. Using this code the influence of different effects (e.g. exact treatment of the resolved resonances, of the asymmetric interference between resonance- and potential-scattering, influence of the weighting spectrum) on the Doppler Coefficient (DC) of a sodium-cooled fast reactor is studied. A comparison of different computational methods for the DC is carried out. The temperature dependence of the DC between 300 and 10000 K is investigated. 30 references. (auth)

20361 (KFK-1791) ASSESSMENT OF COMMERCIALLY AVAILABLE FINITE-ELEMENT-CODES FOR THE DYNAMIC ANALYSIS OF STRUCTURES. Zehlein, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Apr 1973. 76p. (In German). Dep. NTIS (U.S. Sales Only) $6.00.

The theory of the finite-element-method is described. A short introduction to the theory of dynamic analysis of discrete systems is presented. A description of the architecture and capabilities of important, commercially available computer codes for the static and dynamic analysis of structures is included. A distinction is made between General Purpose Program Systems (GPPS) and Special Purpose Program Systems (SPPS), following proper criteria. The 3 most popular GPPS-representatives (STRUDL-II, ASKA, NASTRAN) are explained by direct comparison. Some special purpose systems with outstanding capabilities which have not yet been assimilated by current GPPS's deserve attention as special tools or forerunners for future developments. The information drawn from 21 different codes leads to conclusions regarding the suitability of these programs for application to actual problems of Nuclear Reactor Safety: none of the existing codes possesses the capability for computing large elastoplastic deformations under dynamic loading from reactor accidents. 95 references. (auth)

20362 (RISO-M-1607) γ-MATRIX CONCEPT, A METHOD FOR TREATING HETEROGENEITIES IN DIFFUSION CALCULATIONS. Petersen, T.; Kirkegaard, P. (Danish Atomic Energy

Commission, Risoe. Research Establishment). 1972. 22p. Dep. NTIS (U. S. Sales Only) $3.25.

A method for treating heterogeneities in diffusion calculations for a reactor by means of the γ-matrix concept is described. The heterogeneity is treated as a black box, and the γ-matrix provides the coupling between the diffusion calculation and the black box. Further a Monte Carlo code, MOVAX, for calculating the γ-matrix for a cruciform BWR control rod is described. (auth)

20363 (RT/FI-(73)5) NUCLEAR DATA AND INTEGRAL MEASUREMENTS CORRELATION FOR FAST REACTORS. Part 1. Statistical Formulation. Gandini, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 12 Feb 1973. 44p. Dep. NTIS (U. S. Sales Only) $4.25.

The statistical foundations of the correlation between nuclear data and integral measurements obtained on fast critical assemblies are examined. Special procedures for exploiting the information relevant to fast reactor design are discussed. (JWR)

20364 (WARD/XS-3045-1) STUDIES OF APPLICATIONS OF CROSS SECTION DATA AND CRITICAL EXPERIMENT DATA TO REACTOR DESIGN. Quarterly Progress Report for Period Ending April 30, 1973. Paik, N. C.; Durston, C.; Davis, W. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). May 1973. Contract AT(11-1)-3045. 18p. AT $4.00.

Research progress in nuclear data evaluation, evaluation of design methods, and cross section processing code development is briefly reported. (JWR)

20365 MULTIGROUP DIFFUSION COEFFICIENTS FROM TRANSPORT THEORY. Sheaks, O. J. (Univ. of Maryland, College Park); Sullivan, L. H.; Murray, R. L. Nucl. Sci. Eng.; 51: No. 3, 331-335(Jul 1973).

Operations are performed on the neutron transport equation in general form to obtain an exact multigroup Fick's Law formalism consistent with the standard multigroup conservation equation. The inherent accuracy of the transport equation is maintained in the derived form of the spatially dependent diffusion coefficient, which is shown to be highly dependent on the angular flux spectra. Numerical investigations on fast reactor configurations substantiate the feasibility of incorporating a transport calculated diffusion coefficient in existing diffusion theory codes for reactor design and analysis with dual utility: the errors in diffusion calculations due to incorrect diffusion coefficients can be separated from boundary-condition errors, and the diffusion calculations of certain parametric design studies can be improved to accuracy approaching that of transport theory using spatially averaged diffusion coefficients obtained from a single transport calculation. (auth)

20366 MEASUREMENTS OF SPATIALLY INDEPENDENT REACTIVITY IN PULSED-NEUTRON EXPERIMENTS. Difilippo, F. C.; Pieroni, N. B.; Vinez, J. C. (CNEA, Buenos Aires). Nucl. Sci. Eng.; 51: No. 3, 262-271(Jul 1973).

Through the measurement of the kinetic distortion effect, defined as the modal shape and spectral difference between the fundamental prompt- and delayed-neutron modes, a spatial correction factor for the reactivity of the system, as determined by the Gozani and Garelis-Russell modified pulsed-source methods, is obtained. This factor is the ratio of the experimentally determined and properly normalized delayed- and prompt-neutron densities measured in a pulsed-neutron experiment. With this spatial correction factor the reactivity of the system is obtained as a true global parameter. The results of measurements in several ^{235}U enriched-uranium cores reflected by light water and by graphite and light water are presented. (auth)

20367 THERMAL-NEUTRON SPECTRUM INDEXES IN D_2O-MODERATED URANIUM AND URANIUM–PLUTONIUM FUEL ELEMENTS IN THE TEMPERATURE RANGE FROM 20 TO 200°C. Guardini, S.; Schiavone, N.; Tassan, S. (EURATOM Ispra, Italy). Nucl. Sci. Eng.; 51: No. 4, 405-414(Aug 1973).

Thermal-neutron spectrum indexes in uranium and uranium–plutonium clustered fuel elements, organic-cooled and D_2O-moderated, were measured in the temperature range from 20 to 200°C, by activation of ^{239}Pu–^{235}U and ^{176}Lu–^{164}Dy detector pairs. The experimental results were used to test the multigroup transport code HEROIC and associated cross-section libraries. (auth)

20368 STABILITY OF POWER REACTORS SUBJECT TO STOCHASTIC MACROSCOPIC PARAMETER VARIATION. Krist, G. A. (Westinghouse Electric Corp., West Mifflin, PA); Poncelet, C. G. Nucl. Sci. Eng.; 51: No. 4, 347-375(Aug 1973).

An investigation of the stability of a nuclear power reactor subject to random macroscopic parameter variations is performed. An analysis procedure for determining the effect of stochastic coefficients on the stability in the mean and mean square of linear systems is presented. The procedure is based on Gaussian white process variations which can be shown to be governed by the Fokker-Planck equation. Moment equations are extracted from the Fokker-Planck equation and serve as system equations used for the stability analysis. It is shown that for some simple space-independent reactor models it is possible for random macroscopic parameter variation to destabilize in the mean and mean square a deterministically stable system. Conversely, the study has shown that under certain conditions random macroscopic variation of system parameters can also stabilize in the mean and mean square, a system which is deterministically unstable. A coupled-core spatial reactor model is utilized for the investigation of xenon instability. The results of this analysis again indicate that random macroscopic parameter variation can be a stabilizing or destabilizing influence. Analog simulations of linear systems with stochastic coefficients and a simple reactor model are used to verify the analysis procedure developed in this research. (auth)

20369 FINITE ELEMENT METHODS FOR REACTOR ANALYSIS. Kang, C. M.; Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 51: No. 4, 456-495(Aug 1973).

The application of the finite element method to problems in neutron diffusion in space, energy, and time is studied. The use of piecewise polynomials with a variational form of the diffusion equation leads to algebraic systems of equations with characteristics similar to the usual finite difference equations. A theoretical analysis of the finite element method, with Hermite polynomials, is presented and rigorous error bounds for the approximate solution are developed. Numerical studies are presented for problems in space and time. The results confirm the theoretical analysis and indicate the power of the method for diffusion problems. (auth)

Reactor Components and Accessories

Refer also to abstracts 18399, 18717, 18743, 18795, and 20330.

20370 (AECL-4449) STEAM GENERATOR TUBE FAILURES: A WORLD SURVEY OF WATER-COOLED NUCLEAR POWER REACTORS TO THE END OF 1971. Stevens-Guille, P. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1973. 25p. Dep. NTIS (U. S. Sales Only) $3.25. AECL $1.00.

Steam generators are critical components in water-cooled nuclear power reactors. They are vulnerable to internal leaks which result in radioactive contamination spreading from primary to secondary coolant systems. A world survey shows that 19 of 34 reactors had experienced steam generator tube failures to the end of 1971. Various forms of corrosion were the most frequent cause of failure. A mail survey to reactor operators shows increasing use of eddy current tube inspection and the use of explosive plugs as the preferred steam generator repair method. The world mean time between steam generator failures from defective tubes was 0.6 years at the end of 1971. (auth)

20371 (EURFNR-1075) SINEX: A CODE FOR THERMODYNAMIC AND STRENGTH DESIGN CALCULATION OF SODIUM-HEATED INTERMEDIATE HEAT EXCHANGERS. Schnauder, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Dec 1972. 218p. (In English and German). (KFK-1686). Dep. NTIS $13.00.

Work performed under United States–Euratom Fast Reactor Exchange Program.

A program system is described for the thermal and mechanical design of sodium/sodium intermediate heat exchangers for steady state design conditions. The relatively simple input and easily interpreted output make the system suitable also for parameter studies and optimization calculations. In addition to the usual printout, the results calculated may be plotted in diagrams, and a simplified cross section of the heat exchanger calculated may be plotted. In parameter calculations the influence of the different parameters can also be plotted in diagrams by the computer. 42 references. (auth)

20372 (MRR-112) RECENT DEVELOPMENTS IN MEASUREMENT TECHNIQUES, DATA PROCESSING, AND RELIABILITY INVESTIGATIONS WITH RESPECT TO POWER REACTOR PLANTS. Bastl, W. (Technische Universitaet Muenchen, Garching (West Germany). Laboratorium fuer Reaktorregelung und Anlagensicherung). Dec 1972. 23p. (CONF-720479-1). Dep. NTIS (U. S. Sales Only) $3.25.

From 2nd meeting on the working group nuclear power plant control and instrumentation; Rome, Italy (Apr 1972).

Research progress in the following areas is reviewed: incore neutron flux measurements; instrumentation and data processing, of the SNR (Fast Sodium Reactor); core internals vibration mea-

surements by noise analysis; reactor safety systems; and reliability estimation. (JWR)

20373 SNEAK CIRCUIT ANALYSIS. Rankin, J. P. (Boeing Aerospace Co., Houston, TX). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 30-31(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20374 DEVICE FOR ACTUATING RELATIVELY HEAVY MOBILE PIECES, PARTICULARLY AIR-LOCK DOORS, IN NUCLEAR REACTOR CONTAINMENT SHELLS BY MEANS OF A PRESSURE APPARATUS. Kramer, H. (to Pintsch Bamag Apparatebau GmbH). German Patent 1,941,001. 25 Feb 1971. Filed date 12 Aug 1969. (In German).

This device is characterized by the fact that the mobile part is first accelerated by a constant method that is already known throughout almost known throughout almost half its course and is then slowed down in a constant manner to a minimum speed a short time before the end of its course. (TSS)

20375 OVERFLOW OPENING FOR NUCLEAR REACTOR STRUCTURE. Grahmann, B. (to Siemens AG). German Patent 1,947,421. 15 Apr 1971. Filed date 19 Sep 1969. (In German).

The invention describes overflow openings between the installation space and the operating space in a nuclear reactor structure that in normal use are closed in an airtight manner and in the case of an accident are caused to open by the differential pressure that is produced. The device is characterized by the fact that the overflow openings are closed with a water receptacle in such a manner that the wall separating the installation space and the working space projects above the channels filled with water connecting the installation space and the working space. (TSS)

20376 PRESSURE-VESSEL TYPES AND PROPERTIES OF THE STEELS USED IN THEIR CONSTRUCTION. Neuhaus, W. (Thyssen AG, Oberhausen, Ger.). Stahl Eisen; 93: No. 13, 557-567(1973). (In German).

From meeting on the metallurgy of iron; Duesseldorf, Ger. (9 Nov 1972).

Attempts are made to schematize pressure vessels. Examples are given of different types of pressure vessels. Forces acting on pressure vessels are discussed. Mechanical properties of pressure vessel steels and the influence of cold working and stress annealing on the mechanical properties are discussed. Anisotropy, testing methods, and change of material properties by operating conditions are discussed. Problems of steel selection and specification are considered. (GE)

20377 REMOTE GRIPPING DEVICE. Patarie, L.; Vivien, J. (to Commissariat a l'Energie Atomique). French Patent 2,125,036. 3 May 1971. 7p. (In French).

A remote controlled gripping device intended for the manipulation of polygonal cross section prismatic elements is presented. This type of gripping device can be used in conjunction with a nuclear reactor charging-discharging machine. The device is provided with a casing fixed to a support which is itself provided with at least three movable fingers mounted about axial parts rigidly fixed to the casing. The casing houses the control kinematics for the fingers. A toothed pinion driven by a shaft carried by the support drives a gear ring fixed to a cam which acts upon the tail part of the three fingers. (FR)

20378 PERIODIC INSPECTION OF PRESSURE VESSELS. Conference Held At London, England, May 9-11, 1972. London; Institution of Mechanical Engineers (1972). 274p.

Twenty-eight papers were presented at the Conference. They covered legal requirements for inspection of pressure vessels, in-service inspection of pressurized components used in nuclear plants and inspection practice in other applications, equipment for reactor pressure vessel inspection, future developments including acoustic emission and other techniques, and other aspects such as data handling. Separate abstracts were prepared for 23 papers. (UK)

For abstracts of individual papers see: 20248, 20249, 20253-20255, 20282, 20355, 20379-20392, and 20557.

20379 TECHNIQUE FOR INSPECTION OF LIGHT WATER REACTOR PRESSURE VESSELS. Watkins, B.; Jackson, H. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 21-29 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

Application of the measures advocated in the ASME Section XI Code has led to an increased need for nondestructive testing (NDT) development. The methods employed consist mainly of conventional NDT techniques engineered to withstand the particular environment. The equipment must be capable of operating up to a depth of 100 ft of water in a high radiation background to a high standard of sensitivity and reproducibility. As the daily outage cost for a power reactor is several orders of magnitude greater than the daily cost of inspection, it is essential that the inspection time be kept to a minimum. Additionally, the aim of any inspection is to compare the current results with earlier and base-line data, and for this reason all the records must be immediately available and comparable for assessment. A description is given of NDT techniques evolved to meet these requirements. (auth)

20380 EVALUATION OF ACOUSTICAL HOLOGRAPHY FOR THE INSPECTION OF PRESSURE VESSEL SECTIONS. Dau, G. J. (Battelle Pacific Northwest Labs., Richland, WA); Worlton, D. C.; Collins, H. D. pp 30-43 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The feasibility of using acoustical holography for the detection and measurement of flaws in thick-walled reactor pressure vessels is demonstrated. A brief discussion of the holographic imaging system and hologram reconstruction is given. Results presented include those which demonstrate porosity imaging in weld zones, flaw detection in rotor sections, and resolution capability. The resolution measurements indicate that the system will perform at the predicted value. Perhaps the most significant results are those which demonstrate that one hologram contains all the information necessary to image flaws at many different depths within an object. Design criteria are given for a prototype system for field evaluation. (auth)

20381 IN-SERVICE INSPECTION OF PRESSURE VESSELS. Statutory Inspections. Brown, J. C.; Nickels, P. J.; Warwick, R. G. (Associated Offices Technical Committee, Manchester, Eng.). pp 44-53 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

Examination of Boiler Explosion Acts reports shows it is the latter non-nuclear plants which constitute the greater hazard to life and property. Several incidents involving explosion of pressure plants are examined and the conclusion is drawn that periodical inspection alone cannot prevent every type of accident, that in most instances traditional visual methods developed over the years and conducted by trained engineer surveyors provide adequate safeguard, and that the value of modern techniques is recognized and employed by the inspecting authorities. The inspection approach to specific types of pressure plants is considered in greater detail, followed by an examination of the dangers involved and inspection requirements for safety devices the function of which is to protect boilers and pressure vessels from shortage of water, overpressure, etc. The problems of present-day process plants are considered, in which corrosion rates greatly exceed the figure anticipated in a more conventional plant which is inspected at intervals measured in years. A brief outline is given of techniques adopted by the inspecting authorities to give warning of a developing dangerous situation. (auth)

20382 ACOUSTIC EMISSION AS AN AID TO PRESSURE VESSEL INSPECTION. Bentley, P. G.; Burnup, T. E.; Burton, E. J.; Cowan, A.; Kirby, N. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 54-66 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

Developments in acoustic-emission monitoring as a non-destructive tool to aid pressure vessel inspection are described. An experimental facility, SWEL, has been built and tested, which is capable of detecting and locating small flaws from the acoustic signals received by up to 10 sensors mounted on the pressure vessel during a pressure test. Measurements have been made using early components of this facility to gain experience on large pressure vessels at manufacturers' works. Measurements have been made in the laboratory of emission rates from artificial defects in test pieces and pressure vessels of low- and medium-strength steels. Thus, the capability is now available to make a 100% inspection of pressure vessels over a wide range of engineering steels, and there is the prospect, with further development, of monitoring during operation the severity of any defects relative to vessel failure. (auth)

20383 INSPECTION OF PRESSURE PARTS IN PROTOTYPE NUCLEAR REACTOR CIRCUITS. Carson, J. M. (Lloyd's Register of Shipping Industrial Services, Croydon, Eng.); Turner, F. pp 67-75 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The periodic inspection programs used in reactor installations producing nuclear power are described. These cover the Calder and Chapelcross reactors, the Windscale advanced gas cooled reactor, and the Winfrith Heath steam generating heavy water reactor. The inspection methods used include irradiation monitoring of material properties (surveillance), temperature and deflection measurements, creep strain measurement, nondestructive testing, and visual and TV observations. An account is given of some of the inspections carried out and comments are made on future procedure. (auth)

20384 UTILIZATION OF ACOUSTIC EMISSION FOR IN-SERVICE INSPECTION. Schofield, B. H. (Teledyne Materials Research Co., Waltham, MA). pp 76-82 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The utilization of acoustic emission for reactor vessel in-service inspection shows considerable promise. A description is given of the emission characteristics significant to pressure vessel surveillance and their utilization in precluding catastrophic failure, and the detection and locating of defects in the structure. The typical components of an emission surveillance system are discussed, followed by a review of the current state of the art. (auth)

20385 PRESENT STATUS OF IN-SERVICE INSPECTION FOR NUCLEAR POWER REACTORS IN JAPAN. Ando, Y. (Japan Electric Association, Tokyo). pp 83-92 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The direction of in-service inspections in Japan, based on the ASME Code Section XI, is described. Details are given of the following: in-service inspections carried out on power reactors; future trends; inspections made in areas where problems have occurred in the existing power reactors; and developments relating to techniques of in-service inspection. (UK)

20386 AUTOMATED, MOBILE, X-RAY DIFFRACTOMETER FOR MEASURING RESIDUAL STRESSES IN OPERATING EQUIPMENT. Crisci, J. R. (Naval Engineering Experiment Station, Annapolis, MD). pp 110-118 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

Residual stresses which develop in structures during fabrication may be detrimental to the life and performance of a structure during service. An automated mobile x-ray stress diffractometer that is capable of determining non-destructively the surface stresses in large immovable structures has been developed. The theory is discussed and a description is given of the instrumentation. The accuracy of the data is considered together with mechanical alignment requirements of the diffractometer. Finally some typical surface stress determinations using x rays are presented. (UK)

20387 ULTRASONIC TECHNIQUES FOR REMOTE INSPECTION OF NUCLEAR REACTOR VESSELS. Posakony, G. J. (Automation Industries Inc., Boulder, CO). pp 119-125 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

Remote ultrasonic inspection of nuclear reactor vessels is accomplished in a number of ways. The approach is dependent on access to the inspection surface. To inspect the vessel from the inside surface requires removal of the head and internals. To inspect the vessel from the outside surface requires a space between the vessel wall and thermal insulation for the test heads and the mechanical equipment. After establishing the vessel access there are various ultrasonic techniques, equipment, and instruments that can provide an accurate test. Techniques that are in current use are described. (UK)

20388 SAFETY AND RELIABILITY REQUIREMENTS FOR PERIODIC INSPECTION OF PRESSURE VESSELS IN THE NUCLEAR INDUSTRY. O'Neil, R.; Jordan, G. M. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 140-146 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

After briefly deriving standards required for steel pressure vessels containing primary coolants in nuclear reactors, consideration is given to safety and reliability factors and their relative importance. These include design, manufacturing, construction, inspection, and testing standards, as well as the fracture mechanics methods involved in specifying tolerable defect sizes and inspection sensitivity. New inspection and testing techniques soon to become available are also outlined. The standard of safety and reliability likely to be achieved in the nuclear industry by pressure vessels which are built, inspected, tested, and repeat tested in accordance with the recommended procedures, is indicated. (auth)

20389 RESEARCH AND DEVELOPMENT PROGRAMME ON IN-SERVICE INSPECTION IN THE UNITED STATES OF AMERICA. Wylie, R. D. (Southwest Research Inst., San Antonio, TX). pp 147-157 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The research and development in progress in the USA on in-service inspection are summarized. The system approach to component safety is described. Organizations concerned with several major programs are indicated and their activities outlined. The availability of inspection techniques for in-service quality assurance should lead to reduced failure probability but it is emphasized that inspection is only part of the system required to assure plant safety. (UK)

20390 DESIRABILITY OF PROOF TESTING REACTOR PRESSURE VESSELS PERIODICALLY. Formby, C. L. (Central Electricity Generating Board, Berkeley, CA). pp 185-193 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The need for periodic proof testing is considered in relation to factors which can cause deterioration in service. Fatigue, irradiation damage, strain-ageing, and creep are examined and it is found that the safe working life is limited by them only when an extremely long crack is present initially. The lifetime guaranteed in these critical circumstances by a repeat proof test is impossible to predict with any accuracy, and the repeat proof test could itself, shorten the life. Some other ways of increasing confidence in reactor vessels are mentioned and the nature of these is such that it is nearly as easy to guarantee a vessel for its entire life as for the time between proof tests. The conclusions arrived at strongly oppose the use of repeat proof testing as a general safeguard, at least in simple, all-welded structures of the type examined. (auth)

20391 PLANNING FOR IN-SERVICE INSPECTION OF NUCLEAR REACTOR COOLANT SYSTEMS IN THE USA. Phipps, R. L. (Westinghouse Electric Corp., Pittsburgh). pp 194-199 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

ASME Code requirements, on which in-service inspection planning is based, are reviewed. Categories of inspection required by the code are described. The importance of design and accessibility reviews, the establishment of system boundaries, and the application of exclusion criteria with respect to inspection planning are discussed. (auth)

20392 CONTINUOUS MONITORING OF NUCLEAR REACTOR PRESSURE VESSELS BY ACOUSTIC EMISSION TECHNIQUES. Vetrano, J. B.; Jolly, W. D.; Hutton, P. H. (Battelle Pacific Northwest Labs., Richland, WA). pp 221-226 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

Research is described to develop a system that will continuously monitor nuclear reactor pressure vessels during operation to detect any incipient flaw growth. The system, that has been developed, is based on the acoustic emission phenomenon and is capable of detecting subcritical cracks in pressure vessel steels in the presence of temperatures, fluxes, and hydraulic flows that are characteristic of those in operating nuclear power plants. (auth)

20393 AUXILIARY DEVICE FOR THE REMOVAL OF FUEL ELEMENTS IN NUCLEAR REACTORS. Ulrich, W.; Huetti, A. (to Licentia Patent Verwaltungs GmbH). German Patent 1,564,301. 19 Feb 1970. Filed date 8 Dec 1966. (In German).

The auxiliary device consists of a grill made of laminas arranged crosswise and directed toward the interior with funnels as inlets arranged on the grill. (TSS)

20394 PRESSURE VESSEL FOR NUCLEAR REACTOR. Machnig, O. H.; Reifenscheild, B. (to Chemische Werke Huels AG). German Patent 1,589,654. 30 Apr 1970. Filed date 17 Nov 1967. (In German).

A pressure vessel for a nuclear reactor is provided on the surface with an internal covering (lining) of steel. If there is space, a sheath of concrete surrounds it stopping the radiation. It is surrounded by a sheath of annealed and reinforced synthetic resin which absorbs, in part or entirely, the internal pressure. (TSS)

20395 LOADING MACHINE FOR NUCLEAR REACTOR FUEL ELEMENTS AND CONTROL RODS. Krueger, J.; Schabert, H. P.; Schubert, F. (to Siemens AG). German Patent 1,764,176. 13 May 1971. Filed date 18 Apr 1968. (In German).

A loading apparatus for nuclear reactor fuel elements and control rods is described which is characterized by a vertically adjustable double hook with respectively an independently utilizable hook for the control rod and a hook for the fuel elements. (TSS)

20396 PRESTRESSED CONCRETE PRESSURE VESSEL. Ritz, R. (to Gesellschaft fuer Kernforschung mbH). German Patent 1,684,684. 15 Apr 1971. Filed date 3 Aug 1966. (In German).

A vessel with a pressure cover is described which is composed of rings placed coaxially one on top of the other characterized by the fact that the pressure cover consists of prefabricated, preconstrained rings in the radial as well as tangential direction which after coaxial superposition are cross bars one on the other in the same manner as in the axial direction. (TSS)

20397 METHOD OF MONITORING A NEUTRON FLUX WITH A CERAMIC NEUTRON FLUX MONITOR. Snajdr, E. A. (To United States Atomic Energy Commission). U. S. Patent 3,719,825. 6 Mar 1973. Filed Date 24 May 1971. 6p.

A method is given for monitoring the neutron flux of a nuclear reactor at high temperatures. Monitors are pressed and sintered ceramic pellets containing about 99 percent finely ground, high-purity magnesium oxide as matrix material and about 1 percent finely ground, high-purity nickel monooxide or cobaltous oxide uniformly distributed in the matrix material as an activation compound. (Official Gazette)

20398 SPACE-DEPENDENT NEUTRON NOISE SPECTRA IN BARE AND D_2O-REFLECTED REACTOR LATTICES. Thomas, C. O. Jr. (E. I. du Pont de Nemours and Co., Aiken, SC); Hanauer, S. H.; Baumann, N. P. Nucl. Sci. Eng.; 51: No. 3, 253-261(Jul 1973).

Experiments were performed on a large nuclear reactor to investigate the effects of detector placement and reflection on neutron noise spectra and space dependence of detector efficiency. The magnitudes, break frequencies, and roll-off slopes of the spectra were found to be affected by both detector placement and reflection. The space dependence of detector efficiency was found to be proportional to that of average detector count rates. (auth)

20399 METHOD OF MEASURING ENTRAINED GAS IN A LIQUID USING A CONVERGING-DIVERGING NOZZLE. Henry, R. E. (to United States Atomic Energy Commission). U. S. Patent 3,738,154. 12 Jun 1973. Filed date 20 Oct 1971. 8p.

A choked converging-diverging nozzle is employed in a method of detecting the presence and measuring the volumetric concentration of entrained gas in a liquid. The liquid-gas mixture is accelerated through the nozzle to critical flow conditions and the pressure at the throat of the nozzle is measured. The temperature and pressure of the mixture of the stagnation region are monitored, the throat pressure of the liquid-gas mixture being a function of only the void fraction at any given stagnation temperature and pressure. The method is employed in safety instrumentation for a liquid-cooled nuclear reactor. The throat pressure is monitored with an increase in the throat pressure indicating an undesirable increase in the concentration of entrained gas in the liquid coolant of the reactor which operates at approximate steady state conditions. (Official Gazette)

Reactor Fuels

Refer also to abstracts 17913, 17914, 18195, 18196, 18199, 18602, 18604, 18607, 18615, 18621, 18630, 18640, 18642, 18653, 18700, 18711, 18733, 18736, 18839, 18876, 18888, and 20316.

20400 (EURFNR-1073) EVALUATION OF POST-IRRADIATION EXAMINATION OF UO_2/PuO_2 FUEL PINS IN TEST GROUP FR-2-4a. Dienst, W.; Goetzmann, O.; Kleykamp, H.; Ondracek, G.; Schulz, B.; Zimmermann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Jan 1973. 75p. (KFK-1727). Dep. NTIS $5.75.

Work performed under United States–Euratom Fast Reactor Exchange Program.

In the capsule-irradiation test series FR 2–4a, short UO_2-PuO_2 fuel rods (80 mm fuel length) of 7.4 mm outer diameter were irradiated at mean rod powers of about 350–500 W/cm to 10–95 MWd/kg (U + Pu) burnup. The void volume distribution in fuel rod cross-sections was investigated by measuring crack widths, central hole diameters, and porosity. To calculate the fuel temperature profile, a thermal analysis was made assuming constant heat source density. The amount of fission gas was measured in 3 steps as released fission gas, fission gas retained in large bubbles and fission gas retained in small bubbles and crystal lattice sites. Radial fuel redistribution resulted in a Pu-enrichment around the central void amounting to 23–26% PuO_2 (original content 15%). Fission-product compound composition and distribution as well as plutonium redistribution was examined by microprobe analysis. A large number of fission product metal and oxide phases could be found in the fuel and in the gap between fuel and cladding. The chemical compatibility between the UO_2-PuO_2 fuel (original O/M = 1.98 ± 0.015) and the cladding of stainless Cr–Ni steel CrNiMoVNb 16 13 (No. 4988) proved difficult to be judged because of the thermal conditions changing during irradiation. Apparently an observable chemical attack on the cladding resulted, whenever the inner surface temperature had been above 500°C for some time. In most cases the micrographs showed grain boundary attack, up to a maximum penetration depth of 110 μm. A burnup dependence was not recognizable. (auth)

20401 (IAEA-143(Vol.1), pp 309-312) PERSPECTIVE OF Pu RECYCLING IN FRANCE. Guillet, H. (CEN de Cadarache, Saint-Paul-les-Durance, France). 1972. (In French).

From panel on plutonium recycling in thermal power reactors; Vienna, Austria (21 Jun 1971).

The recycling of plutonium in water-cooled reactors is planned for the near future. France, which has experience in the production and use of plutonium, intends to take part in this activity. Some specific actions that are planned include: specification for a plutonium reload fuel for plants of the Fessenheim type, manufacture of an experimental plutonium fuel by means existing at Cadarache, and study of the specifications for a 100 ton/year plant to be put in operation in 1980 with a possible extension to 300 tons/year by about 1990. (INIS)

20402 (KFK-1704) BURNUP DETERMINATIONS IN FUEL SAMPLES IRRADIATED IN THE FR2 REACTOR. Hoffmann, H.; Wertenbach, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Apr 1973. 79p. (In German). Dep. NTIS (U.S. Sales Only) $6.00.

A survey is presented of the methods of determining the burnup of enriched fuel (UO_2; max. 12.5% U-235). The pins were irradiated in the FR2 reactor up to a burnup of 90,000 MWd/t heavy atoms. Including a discussion of errors the following types of burnup determination are treated: γ-spectrometric method; neutron physics method with Co-detectors; radiochemical methods founded on measuring the activity of ^{90}Sr, ^{106}Ru, ^{137}Cs, ^{144}Ce, ^{148}Nd (after neutron activation) and the concentration of ^{99g}Tc photometrically; mass spectrometrical determination of ^{148}Nd and of the composition of the uranium isotopes; and calorimetric methods including measurements of temperature and quantity of coolant and measurements of the temperature with thermocouples in the capsules. The radiochemical methods showed that ^{137}Cs and ^{99g}Tc are not suitable as burnup detectors because of their tendency to migrate. The ^{144}Ce method was directly compared with the calorimetric method for irradiated samples from capsule group No. 3. The discrepancies were explained as irradiation damage of the thermocouples and seasonal deviations of the D_2O temperature of the reactor FR2. Both methods show uncertainties of the same magnitude (5 to 6%). 58 references. (auth)

20403 (KFK-1803) ASSESSMENT OF THE COMPATIBILITY BEHAVIOR OF OXIDE FUEL PINS. Goetzmann, O.; Hofmann, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). May 1973. 29p. (In German). Dep. NTIS (U.S. Sales Only) $3.50.

The compatibility of oxide fuel pins is described. Possible factors, such as degree of burnup, inner wall temperature, fuel O/M-ratio, impurities in the fuel, and others, which may have an influence on the compatibility are described, and an assessment of their effect is given. Conclusions are presented. (46 references) (auth)

20404 THERMOCOUPLES FOR SURFACE TEMPERATURE MEASUREMENT IN MULTIELEMENT NUCLEAR FUEL BUNDLES. Flemons, R. S. (Canadian General Electric Co. Ltd., Peterborough, Ont.); Lane, A. D. pp 1875-1888 of Temperature: Its Measurement and Control in Science and Industry. Vol. 4, Pt. 3. Finch, D. E. (ed.). Pittsburgh; Instrument Society of America (1972).

From 5th symposium on temperature; Washington, District of Columbia, USA (21 Jun 1971). See CONF-710604-(V4)(P3).

The development of nuclear fuels for the Canadian Power Reactor Program has been supported by an extensive program of surface temperature measurement on experimental fuel assemblies. Miniature, mineral-insulated, stainless steel sheathed thermocouples are attached by brazing to various zirconium alloy and stainless steel fuel sheaths. Fuel assemblies instrumented in this way have been used to: Detect dryout in boiling water coolants, measure sheath temperatures in organic coolants, superheated steam, and post-dryout boiling water, and to investigate the effect of fouling deposits. The advantages of this type of thermocouple attachment are that it minimizes the degree to which the instrumented element must deviate from a prototypical fuel element and it can be accommodated in close packed multi-element fuel bundles. Three methods of attachment are described. One uses a thin cover with a streamlined recess for the thermocouple. A second mounts a severely flattened thermocouple with a solid tip. The third buries thermocouples within the fuel sheath wall. In each case the aim is to minimize the disturbance of coolant flow and the perturbation of temperature distribution caused by the presence of the thermocouple. The attachment techniques are described including methods of braze alloy placement, heating and temperature control. Data on in-reactor performance are included. (auth)

20405 DESIGN OF A LOW-POWER REACTOR FOR ON-LINE MEASUREMENT OF BURNUP OF THTR FUEL. Johnstone, I.; Gunnill, G.; Lawrence, L. A. J. (Atomic Energy Establishment, Winfrith, Eng.). pp 133-137 of Post-Irradiation Examination Techniques. London; Institution of Civil Engineers (1972).

From conference on post-irradiation examination techniques; Reading, UK (22 Mar 1972). See CONF-720319-.

A low-power graphite-moderated reactor using enriched uranium–aluminum alloy fuel was designed for measuring the burnup of irradiated fuel balls from the 300-MW(e) THTR now under construction in Germany. The reactor system incorporates a small on-line computer which (a) calculates the fuel burnup from the transient disturbance to the neutron flux caused by the passage of a ball through the reactor, and (b) exercises closed-loop control through a fine control rod to rebalance the reactor before the arrival of the next ball 7 seconds later. A zero-energy mockup of the reactor was tested at Winfrith during 1970 and the results showed that the final system will be capable of determining the fissile content of an irradiated ball with a standard deviation of ±5 mg ^{235}U equivalent. (auth)

20406 FUEL PARTICLES FOR HIGH TEMPERATURE NUCLEAR REACTORS. Hackstein, K. G.; Schmitten, W. (to Nukem Nuklear Chemie and Metallurgie GmbH). German Patent 1,927,866. 3 Dec 1970. Filed date 31 May 1969. (In German).

The fuel particles thick exterior layer is subdivided by means of porous partitions into a sufficient number of partial layers in a way that their thickness is reduced to about 20 to 50 microns. (TSS)

20407 NUCLEAR REACTOR FUEL ELEMENT. Krauth, A.; Muller, N. (to Nukem Nuklear Chemie and Metallurgie GmbH). German Patent 1,929,203. 17 Dec 1970. Filed date 9 Jun 1969. (In German).

The fuel element contains some pressure pieces with a base of hydrocarbon or nitrides in place of pressure pieces in oxides of nuclear fuel. (TSS)

Reactor Control Systems

Refer also to abstracts 18393–18398, 18400, and 18404.

20408 (AEEW-R-867) CALCULATION AND USE OF SPATIAL TRANSFER FUNCTIONS FOR THE CONTROL ANALYSIS OF XENON INDUCED TRANSIENT PHENOMENA. Owens, D. H. (Atomic Energy Establishment, Winfrith (England)). May 1973. 28p. Dep. NTIS (U.S. Sales Only) $3.50.

With the advent of thermal, nuclear power reactors of increasing physical size, the control of transient variations in the spatial power distribution has taken on increasing economic significance. The specific problem discussed is the oscillation of the power density in a nuclear reactor, such that a "hot spot" moves from one region of the reactor into another and back again in the course of time. In the absence of remedial control action, it is possible that the amplitude of the oscillation can grow with time or be of such a magnitude that melting of metallic components in the core can occur and in the long term, thermal cycling can induce metal fatigue and subsequent fracture. For such cases, specific remedial control action will be required. The application of multivariable control theory is described for the development of a multivariable frequency domain approach to the synthesis of feedback control systems for the xenon-induced azimuthal spatial power modes in a cylindrical nuclear power reactor. 46 references. (auth)

20409 (AEEW-R-868) OPTIMIZATION OF XENON CONTROL MARGINS DURING POWER MANOEUVRES. Owens, D. H. (Atomic Energy Establishment, Winfrith (England)). Apr 1973. 23p. Dep. NTIS (U. S. Sales Only) $3.25.

The problem of (r, θ) form factor optimization during overnight power reduction can be formulated in the context of the optimal control theory. The suggested technique for the solution of the optimization problem is numerically feasible and could form the basis for solution of more complex models. (auth)

20410 (HEDL-SA-555) NEUTRONIC EFFECTS OF IRRADIATION EXPERIMENT LOADING ON FTR ENVIRONMENT. Rothrock, R. B. (Hanford Engineering Development Lab., Richland, Wash.). [nd]. 11p. (CONF-730910-7). Dep. NTIS $3.00.

From international conference on irradiation experimentation in fast reactors; Jackson Hole, Wyoming, USA (10 Sep 1973).

Effects of varying experiments loadings on the FTR neutronic environment are described, and shimming techniques available for compensating such effects are discussed. Calculational examples of specific experiment loading configurations are presented, demonstrating the effectiveness of peripheral absorber shims in maintaining a balanced power shape. 7 references. (auth)

20411 (ORNL-TM-4182) POSTIRRADIATION EVALUATION OF BORON CARBIDE FROM EBR-II HIGHER WORTH CONTROL ROD. Copeland, G. L.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.). Jun 1973. Contract W-7405-eng-26. 20p. Dep. NTIS $4.00.

The EBR-II higher worth control rod, assembly L-4008S, was irradiated to a maximum burnup of about 1.8% of ^{10}B at a maximum temperature of about 500°C. The natural ^{10}B boron carbide pellets from two rods of this assembly were evaluated. The evaluation included ^{10}B analysis to determine burnup, x-ray analysis to determine lattice swelling, metallography, transmission and scanning electron microscopy to evaluate the structural changes, and vacuum fusion to determine the degree of helium retention. The boron carbide performed well in this application. Only minor microcracking occurred, and pellet swelling was low. Most of the helium generated appears to have been retained in the pellets. Defects observable by transmission electron microscopy were identified as platelike cavities containing helium at a pressure in excess of the surface tension restraint. The behavior of these cavities and the lattice parameters during annealing was similar to previously examined fast-reactor-irradiated boron carbide. Gas bubble coalescence on the grain boundaries was also observed after annealing. (auth)

20412 NUCLEAR REACTOR CONTROL ROD DEVICE. Aleite, W.; Bortolazzi, K. (to Siemens AG). German Patent 1,764,577. 6 May 1971. Filed date 26 Aug 1968. (In German).

A nuclear reactor control rod device is described that consists of several control rods in the form of fingers that can be inserted between the fuel elements. The fuel elements are fitted with a common support in the form of a lattice that can be displaced in a vertical direction by means of a driving device. The support contains spring mechanisms to move the control rods. (TSS)

20413 ARRANGEMENT FOR FAST SHUTDOWN OF A NUCLEAR REACTOR BY MEANS OF NEUTRON-ABSORBING LIQUIDS. Friedrich, H. J.; Kruger, H.; Rasche, G. (to Interatom Internationale Atomreaktorbau). German Patent 1,940,403. 18 Feb 1971. Filed date 8 Aug 1969. (In German).

The device is characterized by the fact that the neutron-absorbing liquid is stored in a container above the core of the reactor. At the lower extremity of the container is attached a series of pipes without a cutoff that lead upward to above the highest position of the absorber liquid. From there the pipes lead downward into a container in the core of the reactor. (TSS)

20414 REGULATION OF THE POWER OF A NUCLEAR PLANT. Ernst, H.; Preusche, G. (to Licentia Patent Verwaltungs GmbH). German Patent 1,945,299. 11 Mar 1971. Filed date 6 Sep 1969. (In German).

The regulation of the power of a nuclear plant with a gas-cooled nuclear reactor where the gas coolant is connected in a direct circuit with the turbine is characterized by the fact that the admission valve to the turbine is the element in the circuit that regulates the pressure. A supplementary regulating circuit is provided for the turbine power so that the temperature variation is adjusted proportionally to the theoretical value of the circuit regulating the pressure and acts on the system for adjusting the power of the reactor. (TSS)

20415 SYSTEM FOR THE QUICK SHUTDOWN OF A MOBILE NUCLEAR REACTOR. Mundt, D. (to Interatom Internationale

Atomreaktorbau). German Patent 1,805,976. 27 May 1970. Filed date 30 Oct 1968. (In German).

A system for the rapid shutdown of a mobile nuclear reactor and in particular for the maintenance of a switching state independent of the position taken by the reactor is described. In turning a pin in one direction or the other, this system makes it possible for the easy entrance or removal of the control rod, with precision, from the fission zone of the reactor. (TSS)

20416 CONTROL MECHANISM FOR BREEDER REACTORS. Pawlitzki, R. (to Siemens AG). German Patent 1,957,610. 27 May 1971. Filed date 15 Nov 1969. (In German).

A liquid metal cooled reactor is described which is composed of a core with fuel or fertile elements of angular section as well as control rods of which the insertion depth in the aligning elements can be regulated by means of a rod which is introduced through the lid of the pressure vessel of the reactor. (TSS)

20417 NUCLEAR REACTOR ABSORBING ROD. Sturmer, W.; Handel, H. (to Brown Boveri Krupp Reaktorbau GmbH). German Patent 1,953,905. 6 May 1971. Filed date 25 Oct 1969. (In German).

An absorbing rod for nuclear reactors is described in which the exterior part forms a sheath in the interior space of which is found an absorber. The absorbing rod serves to regulate the power of the reactor or the temperature of the cooling gas. The absorbing part can be displaced along the axis of the interior of the sheath. (TSS)

Nuclear Power Plant Economics

Refer also to abstract 20277.

20418 (INIS-mf-394, pp 11-21) PROSPECTS FOR ATOMIC ENERGY IN AUSTRALIA. Baxter, J. P. (Australian Atomic Energy Commission, Coogee). May 1972.

Atomic energy is considered as a major source of electric power in Australia, and as the basis for an Australian nuclear materials industry. Availability and cost of fuel, capital costs of power stations, operating characteristics and life, fast breeder reactors, and effect of environmental controls are among aspects of planning topics to be given consideration. (INIS)

20419 ANALYSIS AND OPTIMIZATION OF THE CYCLES OF ATOMIC LIQUID-METAL MHD INSTALLATIONS. Morozov, A. E.; Syas'kin, Yu. M.; Shpil'rayn, E. E. pp 268-282 of Magnitogidrodinam. Metod Polucheniya Elektroenergii. Moscow; Energiya (1972). (In Russian).

A technique is presented for optimizing the cycles of atomic liquid-metal MHD installations by an analysis of the expended electrical energy. The cycle of an MHD injector installation is investigated. It was found that for a given surface of the scram system of the nuclear reactor and the maximum permissible temperature at the center of the fuel elements and also for the condition of independence of the effectiveness of the two-phase nozzle of the injector from the initial stage of steam dryness, the optimum cycle should be the cycle in which the initial point of the process of steam expansion is located in the left boundary curve. The effect of the fuel component cost of electrical energy on the selection of optimal parameters of the cycle is analyzed. It is shown that with an increase in the fuel component the initial parameters of the cycle also rise. The case when the upper temperature of the cycle is limited by structural considerations is considered. In this case the optimal dryness of the vapor is in the range 0-0.1. (JPRS)

20420 THERMAL AND WATER-FLOW DESIGN OF A SINGLE-LOOP ATOMIC POWER STATION. Margulova, T. Kh.; Zorin, V. M. Tr. Mosk. Energ. Inst.; No. 126, 70-78(1972). (In Russian).

The thermal design of a single-loop atomic power station is investigated. Features of selecting the thermal design considering water requirements are determined. Ensuring the durability and reliability of the operation of the shells of the fuel elements, the water-vapor regime of the turbine, and reducing the extent of activity in all elements of the circuit lead to requirements imposed on the quality of the reactor. Expenditures on equipment and assembly, transportation and storage expenses, and other expenditures were taken into account in the power station design. (JPRS)

20421 STATE OF THE NUCLEAR ENERGY ECONOMY IN THE USA IN 1972. Wylie, R. D.; Meckel, N. T. (Southwest Research Inst., San Antonio, TX). Arch. Energiewirt.; 27: No. 4, 195-202 (1973).

The development of the nuclear industry and the electric power supply in the USA are described. The main industrial problems involved in the development of nuclear power are discussed in the conclusion. (GE)

20422 IMPROVEMENTS IN THE MEANS FOR PRODUCING, TRANSPORTING, AND DISTRIBUTING ELECTRICITY AND THE OUTLOOK FOR THE YEAR 2000. Dejou, M. (Electricite de France, Paris). Rev. Fr. Energ.; 24: No. 249, 140-143(Jan 1973). (In French).

From electricity in the year 2000; Paris, France (7 Jun 1972).

In years to come an increasing amount of electrical energy will be of nuclear origin. The breeder type reactors envisaged for 1980 will enable an economical technique to be developed for the utilization of controlled fusion energy, the production of which is not foreseen until the end of the century. There is, however, a possibility for the development of a second generation of nonbreeder thermal neutron reactors before the end of the century (high temperature gas reactors, new light water reactors, heavy water reactors). Reactors of the year 2000 could be equipped with 3000 to 5000 MW turboalternator groups which would permit the 120,000 MW power necessary in the next 30 years to be acquired. The electrical transport network envisaged is a system of aerial transmission lines with European interconnections. (FR)

20423 TEST REQUIREMENTS AND TESTING OF PRESSURE SYSTEMS FOR NUCLEAR POWER STATIONS. Experience with the THTR Liner and Steam Generators. Schleimer, W. Atomwirt., Atomtech.; 18: No. 6, 280-285(1973). (In German).

An essential difference between conventional and nuclear installations is the ratio of test to plant costs. For example, the testing costs for a high pressure pre-heater with an energy content of 2.5×10^6 kcal are about 0.5% of the plant value whereas those for the liner of the 300 MW THTR with an almost identical energy content amounted to 10% of the plant value. The examples demonstrate that the test specifications in many cases should be brought into line with the actual manufacturing process for the units and their components. In this way testing costs could be reduced. (GE)

Reactor Fuel Cycle Economics

20424 (BARC-I-165, pp 191-202) NUCLEAR FUEL MATERIAL ACCOUNTING AND MANAGEMENT AT RAPP AND FUTURE EVOLUTION OF MANAGEMENT POLICIES FOR THE TEN YEAR NUCLEAR POWER PROGRAMME. Rustagi, R. S.; Das, M. (Dept. of Atomic Energy, Bombay). 1972.

From seminar on accountability and management of fissile materials; Trombay, India (13 Apr 1971).

A design description of the fuel assembly at Rajasthan Atomic Power Plant, India is presented. It is designed for on-lead push-through fuelling. Fuel accounting is carried out by characterising the operation of RAPP reactor into two distinct phases: the initial short term "pre-equilibrium" operation; and the subsequent long term "equilibrium" operation. The fuelling cost for the two operations are accounted. A brief explanation of the RAPP fuel burnup is given. The fuel management policies adopted are enumerated. Comparison between the fuel management plan and the expected evolution for the decade 1970-80 is explained. It is concluded that there is ample scope for reducing fuelling cost in heavy water type reactors via reducing fabrication costs, increasing fuel burnup and improving on the fuel performance in the reactors. With these modifications, a fuelling cost of less than 0.5 paise/kwh should be realised around 1980. (INIS)

20425 RECYCLING OF PLUTONIUM IN LIGHT WATER REACTORS. Energ. Nucl. (Paris); 15: No. 1, 60-63(Jan 1973). (In French).

Economic and technological aspects of the recycling of plutonium in light water reactors are examined: world supply of fissile plutonium, priorities, supply and demand, excess plutonium in world market between 1973 and 1975, current state of plutonium recycling technology in light water reactors, and technological developments in the field of plutonium recycling in the European Community. (FR)

20426 ECONOMIC ASPECTS OF THE FUEL CYCLE. Energ. Nucl. (Paris); 15: No. 1, 67-72(Jan 1973). (In French).

The costs of the materials and operations involved in the fuel cycle are reviewed. Estimations are given of the expenses incurred in the different stages of the fuel cycle. The investments envisaged for the various parts of the cycle are presented together with an estimate of the proportion of the overall price per kwh represented by the fuel. (FR)

Reactor Licensing and Regulation

20427 (BNWL-SA-4670) NATIONAL ENVIRONMENTAL POLICY ACT AND NUCLEAR POWER PLANT LICENSING. Shipler, D. B.; Foster, R. F. (Battelle Pacific Northwest Labs., Richland, Wash.). Apr 1973. Contract AT(45-1)-1830. 26p. (CONF-730447-1). Dep. NTIS $3.50.

The National Environmental Policy Act of 1969 states the responsibility of the Federal Government toward the protection of the environment, directs all federal agencies to prepare impact statements for federal actions which significantly affect the quality of the environment, and establishes the Council on Environmental Quality to review federal activities in light of NEPA. The requirements of Environmental Reports for power reactors are described. (auth)

20428 (DOCKET-50133-124) HUMBOLDT BAY POWER PLANT, UNIT 3. Final Safety Analysis Report, Proposed Amendment, July 13, 1973. (Pacific Gas and Electric Co., San Francisco, Calif.). 13 Jul 1973. 45p. Dep. NTIS $4.25.

The analyses concerning postulated piping system ruptures outside the containment for piping systems containing high energy fluids are presented. Various effects of blowdown in the refueling building, caisson access shaft, pipe gallery, pipe tunnel, and the feed pump room are described and modifications to provide adequate protection are proposed. (FS)

20429 (DOCKET-50184-11) NATIONAL BUREAU OF STANDARDS REACTOR. Request from AEC for Additional Information on Supplement A of Final Safety Analysis Report. (Division of Reactor Licensing (AEC), Washington, D. C.). 7 Dec 1966. 6p. Dep. NTIS $3.00.

AEC questions are presented concerning filters in the emergency exhaust and recirculating systems; reliability of the dynamic protection system, elastomer coatings on the internal walls, modifications, and the pressure differential in the confinement building; maximum reactivity insertion; underground control system; personnel for initial startup; failure of shim arm; tritium doses; electrical distribution system; radioactive liquid wastes; the ECCS; fuel handling equipment; manually operated valves; and seismic qualifications. (FS)

20430 (DOCKET-50184-12) NATIONAL BUREAU OF STANDARDS REACTOR. Report on the Difference Between the Calculated and Measured Reactivity. (National Bureau of Standards, Washington, D. C.). 8 Mar 1968. 9p. Dep. NTIS $3.00.

20431 (DOCKET-50184-13) NATIONAL BUREAU OF STANDARDS REACTOR. Report on Failure of Shim Arm 4 to Drop Fully Upon Scram. (National Bureau of Standards, Washington, D. C.). 10 May 1968. 6p. Dep. NTIS $3.00.

20432 (DOCKET-50184-14) NATIONAL BUREAU OF STANDARDS REACTOR. Report on Slow Release Time of Shim Arm 4. (National Bureau of Standards, Washington, D. C.). 19 Jul 1968. 4p. Dep. NTIS $3.00.

20433 (DOCKET-50245-234) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Cask Drop Prevention System. (Millstone Point Co., Hartford, Conn.). 29 Jun 1973. 23p. Dep. NTIS $3.25.

20434 (DOCKET-50245-235) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Feedwater Sparger Failure, Interim Report, Addendum 1. (Millstone Point Co., Hartford, Conn.). 29 Jun 1973. 89p. Dep. NTIS $6.50.

20435 (DOCKET-50245-236) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Supplement 2 to the Full-Term Operating License Application Dated September 1, 1972. (Millstone Point Co., Hartford, Conn.). 16 Jul 1973. 22p. Dep. NTIS $3.25.

The quality assurance program for unit 1 during plant operation, responses to AEC questions on the quality assurance program, and a list of equipment, systems, and components requiring installation checks and preoperation tests are provided. (FS)

20436 (DOCKET-50245-237) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Report Describing Efforts to Improve MSIV Reliability, June 28, 1973. (Millstone Point Co., Hartford, Conn.). 28 June 1973. 6p. Dep. NTIS $3.00.

20437 (DOCKET-50245-238) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Additional Information on Feedwater Sparger Failures, June 29, 1973. (Millstone Point Co., Hartford, Conn.). 29 Jun 1973. 2p. Dep. NTIS $3.00.

20438 (DOCKET-50245-239) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Proposed Change Relating to the Isolation Condenser System, June 29, 1973. (Millstone Point Co., Hartford, Conn.). 29 Jun 1973. 8p. Dep. NTIS $3.00.

20439 (DOCKET-50245-240) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Report on the Fuel Pool Liner Leakage and Repair, November 22, 1971-September 16, 1972. (Millstone Point Co., Hartford, Conn.). 29 Jun 1973. 11p. Dep. NTIS $3.00.

20440 (DOCKET-50245-241) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Proposed Change Relating to the Isolation Condenser System, July 9, 1973. (Millstone Point Co., Hartford, Conn.). 9 Jul 1973. 4p. Dep. NTIS $3.00.

20441 (DOCKET-50245-242) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Proposed Change Relating to the Isolation Condenser System, July 11, 1973. (Millstone Point Co., Hartford, Conn.). 11 Jul 1973. 11p. Dep. NTIS $3.00.

20442 (DOCKET-50245-243) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Radwaste Modification. (Millstone Point Co., Hartford, Conn.). 12 Jul 1973. 216p. Dep. NTIS $13.00.

20443 (DOCKET-50245-244) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Reactor Control Blade Evaluation, Special Report, July 23, 1973. (Millstone Point Co., Hartford, Conn.). 23 Jul 1973. 35p. Dep. NTIS $3.75.

20444 (DOCKET-50245-245) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Regulatory Operations Bulletin No. 73-3, Report on Defective Hydraulic Shock Suppressors and Restraints. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 27 Jul 1973. 3p. Dep. NTIS $3.00.

20445 (DOCKET-50245-246) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence AO-73-8. (Millstone Point Co., Hartford, Conn.). 2 Aug 1973. 2p. Dep. NTIS $3.00.

20446 (DOCKET-50245-247) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Special Report on Reactor Control Blade Evaluation, Supplement 1, July 23, 1973. (Millstone Point Co., Hartford, Conn.). 26 Jul 1973. 9p. Dep. NTIS $3.00.

20447 (DOCKET-50255-168) PALISADES PLANT. Request for Change to the Technical Specifications, License No. DPR-20, Amendment 4. (Consumers Power Co., Jackson, Mich.). 13 Jul 1973. 159p. Dep. NTIS $10.00.

A request for changes in the Technical Specifications of the Provisional Operating License concerning thickened pipe walls in the vicinity of containment penetrations and an in-service inspection program for main steam and feedwater lines located in the auxiliary building is proposed. Report No. 6, Revision 1 titled "Analysis of Postulated High Energy Line Breaks Outside of Containment" is revised and updated. (FS)

20448 (DOCKET-50269-118) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 42, Revision No. 29. (Duke Power Co., Charlotte, N. C.). 29 Jun 1973. 256p. (DOCKET-50270-94; DOCKET-50287-84). Dep. NTIS $15.00.

Technical specifications for units 1 and 2, valve operability for units 2 and 3, and revisions on trip testing before start-up after a shutdown are presented. (FS)

20449 (DOCKET-50269-119) OCONEE NUCLEAR POWER STATION, UNIT 1. Safety Evaluation Report by DRL, July 10, 1973. (Directorate of Licensing (AEC), Washington, D. C.). 10 Jul 1973. 129p. Dep. NTIS $8.50.

The facility; site and environment; reactor design; reactor coolant system; reactor building and class 1 (seismic) structures; engineered safety features; instrumentation, control, and power systems; control of radioactive effluents; auxiliary systems; analyses of radiological consequences from design basis accidents; conduct of operations; technical specifications; ACRS report; common defense and security; financial qualifications; financial protection and indemnity requirements are described. Supplements include analyses of ECCS and fuel densification. (FS)

20450 (DOCKET-50270-95) OCONEE NUCLEAR STATION, UNITS 2 AND 3. Safety Evaluation Report by DRL, July 6, 1973. (Directorate of Licensing (AEC), Washington, D. C.). 6 Jul 1973. 181 p. (Docket-50287-85). Dep. NTIS $11.25.

The thermal, hydraulic, and nuclear design of the reactors; the facility; the reactor site and environment; coolant system; the reactor building and class 1 (seismic) structures; engineered safety features; instrument, control, and power systems; control of radioactive effluents; auxiliary systems; analyses of radiological consequences from design basis accidents; conduct of operations; technical specifications, common defense and security, financial qualifications, and financial protection and indemnity requirements of the Oconee-2 and -3 power plants are presented. (FS)

20451 (DOCKET-50277-102) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Draft Environmental Statement, Comments of Baltimore County Office of Planning and Zoning, Maryland. (Philadelphia Electric Co., PA). 15 Jun 1973. 2p. (DOCKET-50278-90). Dep. NTIS $3.00.

20452 (DOCKET-50277-103) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Technical Specifications and Bases, Appendix A, July 1973. (Philadelphia Electric Co., PA). Jul 1973. 175p. (Docket-50278-91). Dep. NTIS $10.75.

Technical specifications concerning fuel cladding, reactor cooling systems, protection systems, protective instrumentation, reactivity control, standby liquid control, core and containment cooling, primary system boundary, containment systems, radioactive materials, auxiliary electric systems, core, river level, major design features, and administrative controls are presented. (FS)

20453 (DOCKET-50281-116) SURRY POWER STATION, UNIT 2. Start-Up Test Report, July 31, 1973. (Virginia Electric and Power Co., Richmond). 31 Jul 1973. 286p. Dep. NTIS $16.50.

Testing performed on safety related equipment prior to criticality, low power physics testing, and transient tests conducted at various power levels are reported. (FS)

20454 (DOCKET-50285-100) FORT CALHOUN STATION, UNIT 1. License Application, Amendment 38, FSAR, Supplement 20. (Omaha Public Power District, NEBR). 26 Jun 1973. 114p. Dep. NTIS $7.75.

Appendix L is superseded by a report, CENPP-99 Revision 1 entitled "Justification for 1420 MW(e) Operation of the Fort Calhoun Reactor Under Fuel Densification Conditions." This report is on file with the AEC. In addition, two new appendices concerning a postulated high energy line rupture outside the containment and a reclassification of plant piping are incorporated in the FSAR. (FS)

20455 (DOCKET-50289-107) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment 36. (Metropolitan Edison Co., Reading, PA). 9 Feb 1973. 49p. Dep. NTIS $4.45.

Revisions are presented on the reactor site, testing requirements for valves and pumps, and preoperational testing responsibilities. An AEC question on the containment pressure-time response for various break sizes and break locations through blowdown, reflood and post-reflood is answered. (FS)

20456 (DOCKET-50289-108) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment 41. (Metropolitan Edison Co., Reading, PA). 16 Jul 1973. 428p. Dep. NTIS $23.50.

Revised technical specifications are presented. Also included are revised pages for the plant description, site characteristics, design criteria, the reactor, reactor coolant system, engineered safety features, instrumentation and controls, electric power, auxiliary systems, steam and power conversion systems and radwaste management. (FS)

20457 (DOCKET-50289-109) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Safety Evaluation Report by the Directorate of Licensing (AEC), Washington, D. C.). 11 Jul 1973. 222p. Dep. NTIS $13.25.

The nuclear power plant utilizing a pressurized water reactor is described including the site characteristics; design criteria of structures, components, and systems; the reactor; the reactor coolant system; engineered safety features; instrumentation and controls; electric power; auxiliary systems; steam and power conversion; waste management; radiation protection; conduct of operations; initial tests and operations; accident analysis; technical specifications; quality assurance; common defense and security; financial qualifications; financial protection and indemnity requirements; and the ACRS report. (FS)

20458 (DOCKET-50295-139) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Special Report No. 1, Main Steam Line Check Valve Modification, Supplement B. (Commonwealth Edison Co., Chicago, Ill.). 2 Jul 1973. 91p. (DOCKET-50304-105). Dep. NTIS $6.75.

Calculations performed to determine the dynamic forces acting on the modified main steamline check valves are reported. A tentative surveillance program for the modified valves proposes that nondestructive testing be performed every two weeks during operation to monitor the valve body for erosion; visual inspection of internal components be performed on at least one valve subsequent to the 50% start-up program, and every six months thereafter during planned outages; and the pressure drop across at least two of the valves be recorded at 5% power level increments. (FS)

20459 (DOCKET-50298-83) COOPER NUCLEAR STATION. Safety Evaluation Report, Supplement 1, July 16, 1973. (Directorate of Licensing (AEC), Washington, D. C.). 16 Jul 1973. 40p. Dep. NTIS $4.00.

Revised information is presented concerning the reactor, site, protection against dynamic effects of postulated pipe rupture, reactor cooling system, containment system, ECCS, instrumentation and controls, fuel handling and storage, steam and power conversion system, liquid and gaseous wastes, and accident analysis. Also included is an ACRS review. (FS)

20460 (DOCKET-50302-78) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Response for Additional Information to AEC's Letter of March 12, 1973. (Florida Power Corp., St. Petersburg). 1973. 23p. Dep. NTIS $3.25.

Responses are provided for AEC questions on the model for analysis of open coast storm surge due to a probable maximum hurricane (PMH), safe cold shutdown during a PMH, wave runup over a protected embankment, and safety related structures, components, and systems. (FS)

20461 (DOCKET-50302-79) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Final Safety Analysis Report, Amendment 27. (Florida Power Corp., St. Petersburg). 29 Jun 1973. 84p. Dep. NTIS $6.25.

Revisions concerning the reactor cooling system, engineered safety features, electric power, auxiliary systems, radiation protection, initial tests and operations, and technical specifications are presented. (FS)

20462 (DOCKET-50302-80) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Hurricane Study, Report by Gilbert Associates, Inc., July 11, 1973. (Gilbert Associates, Inc., Reading, PA). 11 Jul 1973. 145p. Dep. NTIS $9.25.

20463 (DOCKET-50302-81) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Final Safety Analysis Report, Amendment 28. (Florida Power Corp., St. Petersburg). 16 Jul 1973. 50p. Dep. NTIS $4.50.

Responses are presented for AEC questions concerning hurricane effects, flood protection, spray in the diesel generator building, embankment slope protection, main steam isolation valves, and turbine emergency stop valves. (FS)

20464 (DOCKET-50302-82) CRYSTAL RIVER NUCLEAR PLANT, UNIT 3. Report Verification Study of Dames and Moore's Hurricane Storm Surge Model with Application, July 13, 1973. (Florida Power Corp., St. Petersburg). 13 Jul 1973. 683p. Dep. NTIS $36.25.

Results of Dames and Moore's hurricane surge computer model verification study for the Crystal River-3 Reactor are presented. The model was calibrated using several specific hurricanes. The coefficients used are surface wind and bottom friction. Validity of the model numerics was determined by comparing with known analytical solutions. Using the verified Dames and Moore hurricane surge model, a Probable Maximum Hurricane (PMH) storm surge elevation of 29.4 ft mean low water (MLW) was calculated. Resulting wave generation and flood elevations resulting from the PMH were also calculated. (FS)

20465 (DOCKET-50305-88) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 31, Technical Specifications, Appendix A. (Wisconsin Public Service Corp., Green Bay). 18 Jul 1973. 219p. Dep. NTIS $13.00.

20466 (DOCKET-50309-117) MAINE YANKEE ATOMIC POWER STATION. Technical Specifications, Appendix A to Operating License DPR-36. (Maine Yankee Atomic Power Co., Westboro, Mass.). 29 Jun 1973. 165p. Dep. NTIS $10.25.

20467 (DOCKET-50309-118) MAINE YANKEE ATOMIC POWER STATION. Precritical Vibration Monitoring Program, Final Report, June 1973. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). 21 Jun 1973. 73p. (CENPD-93 (Rev.1)). Dep. NTIS $5.75.

20468 (DOCKET-50309-119) MAINE YANKEE ATOMIC POWER STATION. Startup Test Report, July 1973. (Maine Yankee Atomic Power Co., Westboro, Mass.). 30 Jul 1973. 354p. Dep. NTIS $19.70.

20469 (DOCKET-50315-126) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Preoperational Environmental Monitoring Report, July 1, 1972-December 31, 1972. (Eberline Instrument Corp., Santa Fe, N. Mex. Dept. of Nuclear Sciences). 13 Jun 1973. (DOCKET-50316-123). Dep. NTIS $5.50.

For Indiana and Michigan Power Co., New York, NY.

20470 (DOCKET-50315-128) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 45. (Westinghouse Electric Corp., Pittsburgh, PA). 13 Jul 1973. 386p. (DOCKET 50316-125). Dep. NTIS $21.50.

For Indiana and Michigan Power Co., New York, NY and Indiana and Michigan Electric Co., New York, NY.

Responses to AEC questions concerning the ice condenser are presented. (FS)

20471 (DOCKET-50315-129) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Environmental Statement by the DRL, August 1973. (Directorate of Licensing (AEC), Washington, D. C.). Aug 1973. 429p. (DOCKET-50316-126). Dep. NTIS $23.45.

The environmental effects of construction and operation of the Donald C. Cook Nuclear Plant, Units 1 and 2 are examined. The descriptions include: the environment in the area, including the history, geography, geology, hydrology, climatology, ecology, land and water use including chemical characteristics; the facility and its effluents; the impacts from construction and operation of the facility; alternatives to the proposed action; irreversible and irretrievable long-term commitments of resources from plant operation; need for power; and the benefits–cost analysis of the proposed plant operation. (FS)

20472 (DOCKET-50317-104) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 38. (Baltimore Gas and Electric Co., MD). 5 Jul 1973. 80p. (DOCKET-50318-98). Dep. NTIS $6.00.

A change is presented concerning pump switches at the feed water intake structure. Answers to AEC questions on the effect of fuel densification on normal operation are given in a report CENPP-106, Rev. 1, "Effect of Fuel Densification on the Calvert Cliffs Safety Analysis." (FS)

20473 (DOCKET-50321-86) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment 36. (Georgia Power Co., Atlanta). Jul 1973. 332p. Dep. NTIS $18.75.

Appendix N to the FSAR, a report entitled "Report on High Energy Pipe Breaks Outside the Primary Containment" is presented. Supplementary information on the site, reactor cooling system, instrumentation and control, the steam and power conversion system, and conduct of operations is also provided. (FS)

20474 (DOCKET-50324-86) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 21. (Carolina Power and Light Co., Raleigh, N. C.). 26 Jul 1973. 44p. (DOCKET-50325-86). Dep. NTIS $4.25.

Revised data on the reactor cooling system, steam and power conversion system, radioactive waste management, and conduct of operations are presented. (FS)

20475 (DOCKET-50333-102) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Report on Reactor Pedestal Crack, June 1973. (Power Authority of the State of New York). Jun 1973. 74p. Dep. NTIS $5.75.

20476 (DOCKET-50333-103) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 25, Supplement 24. (Power Authority of the State of New York). 17 Jul 1973. 46p. Dep. NTIS $4.50.

Revised data, tables, and figures are presented on the reactor; the reactor site; design criteria for structures, components, and systems; and the plant. Revised pages are provided for a special report on "Effects of a High Energy Piping Break Outside of Primary Containment." (FS)

20477 (DOCKET-50334–80) BEAVER VALLEY POWER STATION, UNIT 1. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Jul 1973. 301p. Dep. NTIS $17.25.

The environmental effects of construction and operation of the Beaver Valley Power Station, Unit 1 are examined. The descriptions include: the environment in the area, including the history, geography, geology, hydrology, climatology, ecology, land and water use including chemical characteristics; the facility and its effluents; the impacts from construction and operation of the facility; alternatives to the proposed action; irreversible and irretrievable long-term commitments of resources from plant operation; need for power; and the benefits-cost analysis of the proposed plant operation. (auth)

20478 (DOCKET-50335-65) ST. LUCIE PLANT, UNIT 1. Final Safety Analysis Report, Amendment 13. (Florida Power and Light Co.). 15 Jul 1973. 727p. Dep. NTIS $38.50.

Updated material is presented on electric power, auxiliary systems, steam and power conversion systems, radwaste management, radiation protection, conduct of operations, initial tests and operations, accident analysis, technical specifications, and quality assurance. Editorial corrections and information concerning the hydrogen control system are included. (FS)

20479 (DOCKET-50336-67) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Deficiency Report 4, May 31, 1973. (Millstone Point Co., Hartford, Conn.). 31 May 1973. 3p. Dep. NTIS $3.00.

Stress cone failures occurred during dc high potential testing of 5 kV and 8 kV cables. All failed stress cones were replaced and an additional taped layer was made at the end of the stress grading tubing which fills the air gap and eliminates a flashover. (FS)

20480 (DOCKET-50336-68) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Final Safety Analysis Report, Amendment 18. (Millstone Point Co., Hartford, Conn.). 16 Jul 1973. 124p. Dep. NTIS $8.25.

Responses are given for AEC questions on the engineered safety systems, instrumentation and controls, electric power, and conduct of operations. (FS)

20481 (DOCKET-50336-69) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Regulatory Operations Bulletin 73-2, Malfunction of Containment Purge Supply Valve Switch. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 18 Jul 1973. 3p. Dep. NTIS $3.00.

20482 (DOCKET-50344-66) TROJAN NUCLEAR PLANT. Final Environmental Statement, August 1973. (Directorate of Licensing (AEC), Washington, D. C.). Aug 1973. 379p. Dep. NTIS $21.00.

The environmental effects of construction and operation of the Trojan Nuclear Plant are examined. The descriptions include: the environment in the area, including the history, geography, geology, hydrology, climatology, ecology, land and water use including chemical characteristics; the facility and its effluents; the impacts from construction and operation of the facility; alternatives to the proposed action; irreversible and irretrievable long-term commitments of resources from plant operation; need for power; and the benefits–cost analysis of the proposed plant operation. (FS)

20483 (DOCKET-50354-43) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D.C.). Jul 1973. 473p. (DOCKET 50355-43). Dep. NTIS $25.75.

The environmental effects of construction and operation of the Newbold Island Generating Station, Units 1 and 2 are examined. The descriptions include: the environment in the area, including the history, geography, geology, hydrology, climatology, ecology, land and water use including chemical characteristics; the facility and its effluents; the impacts from construction and operation of the facility; alternatives to the proposed action; irreversible and irretrievable long-term commitments of resources from plant operation; need for power; and the benefits–cost analysis of the proposed plant operation. (auth)

20484 (DOCKET-50361-44) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Amendment 19. (Southern California Edison Co., Rosemead, Calif.). 25 Jul 1973. 53p. (DOCKET 50362-43). Dep. NTIS $4.75.

Revised and supplementary data concerning site slope stability are presented. Questions on dynamic testing of soil properties, the possibility of flattening plant slopes, proximity of Class 1 structures to non-switchyard slopes, vertical components of acceleration considered in slope analysis, and the effect of slope modification on slope stability are answered. (FS)

20485 (DOCKET-50412-24) BEAVER VALLEY POWER STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 8. (Duquesne Light Co., Pittsburgh, PA). 17 Jul 1973. 192p. Dep. NTIS $11.75.

20486 (DOCKET-50412-25) BEAVER VALLEY POWER STATION, UNIT 2. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Jul 1973. 312p. Dep. NTIS $17.75.

The environmental effects of construction and operation of the Beaver Valley Power Station, Unit 2 are examined. The descriptions include: the environment in the area, including the history, geography, geology, hydrology, climatology, ecology, land and water use including chemical characteristics; the facility and its effluents; the impacts from construction and operation of the facility; alternatives to the proposed action; irreversible and irretrievable long-term commitments of resources from plant operation; need for power; and the benefits–cost analysis of the proposed plant operation. (FS)

20487 (DOCKET-50413–34) CATAWBA NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 12. (Duke Power Co., Charlotte, N. C.). 20 Jul 1973. 134p. (DOCKET-50414–34). Dep. NTIS $8.75.

Responses are provided for AEC questions on design criteria for structures, components, equipment, and systems; the reactor cool-

ing system; engineered safety features; electric and auxiliary power; and the steam and power conversion system. (FS)

20488 (DOCKET-50413-35) CATAWBA NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 11. (Duke Power Co., Charlotte, N. C.). 13 Jul 1973. 109p. (DOCKET-50414-35). Dep. NTIS $7.50.

Revised data and responses to questions on design criteria for structures, components, and systems; instrumentation and controls; and electric power are presented. (FS)

20489 (DOCKET-50416-40) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Environmental Report, Amendment 4. (Mississippi Power and Light Co., Jackson (USA)). 1 Aug 1973. 112p. (Docket-50417-40). Dep. NTIS $7.75.

Revisions are presented concerning the environmental effects of site development, plant operation, chemical and sanitary wastes, water treatment and uses, and preoperational environmental monitoring. (FS)

20490 (DOCKET-50416-41) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. License Application, Amendment 1, July 27, 1973. (Mississippi Power and Light Co., Jackson (USA)). 27 Jul 1973. 86p. (DOCKET-50417-41). Dep. NTIS $6.50.

Answers to AEC questions concerning the financial qualifications of the applicants for a license are presented. (FS)

20491 (DOCKET-50423-20) MILLSTONE NUCLEAR POWER STATION, UNIT 3. License Application, Preliminary Safety Analysis Report, Amendment 6. (Millstone Point Co., Hartford, Conn.). 20 Jul 1973. 549p. Dep. NTIS $29.50.

Responses to AEC questions are presented on missile protection, high energy fluid line rupture outside the containment, pipe whip, operation of faulted equipment, design of reactor internals, seismic qualification of instrumentation, design criteria for reactor coolant pressure boundary, stress levels of Class 1 components, computer programs for stress analysis, design of pressure relief valves, off-site power, ventilation systems, diesel engine failure, underground corrosion, failures due to weather, steam and power conversion, and quality assurance. Changes concerning engineered safety systems, instrumentation and controls, electric power, auxiliary systems, and steam and power conversion are described. (FS)

20492 (DOCKET-50423-21) MILLSTONE NUCLEAR POWER STATION, UNIT 3. Suggested Procedures Regarding Discretionary Powers of the Power Facility Evaluation Council to Establish Special Prehearing Measures. (Millstone Point Co., Hartford, Conn.). 11 Jul 1973. 30p. Dep. NTIS $3.50.

20493 (DOCKET-50423-22) MILLSTONE NUCLEAR POWER STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 7. (Millstone Point Co., Hartford, Conn.). 3 Aug 1973. 525p. Dep. NTIS $28.25.

Responses to AEC questions on design criteria, engineered safety systems, electric power, auxiliary systems, the reactor, instrumentation and control systems, and the steam and power conversion systems are presented. Errata and addendum pages are also included. (FS)

20494 (DOCKET-50424-19) ALVIN W. VOGTLE NUCLEAR PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report; License Application, Amendment 4. (Georgia Power Co., Atlanta). 10 Jul 1973. 332p. (Docket-50425-19; Docket-50426-19; Docket-50427-19). Dep. NTIS $18.75.

Responses to AEC questions on seismic design, containment, instrumentation and control, onsite electric power, auxiliary systems, and steam and power conversion systems are provided. (FS)

20495 (DOCKET-50424-20) ALVIN W. VOGTLE NUCLEAR PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 5. (Georgia Power Co., Atlanta). 27 Jul 1973. 153p. (DOCKET-50425-20; DOCKET-50426-20; DOCKET-50427-20). Dep. NTIS $9.75.

20496 (DOCKET-50424-21) ALVIN W. VOGTLE NUCLEAR PLANT, UNITS 1, 2, 3, AND 4. Draft Environmental Statement by the DRL, August 1973. (Directorate of Licensing (AEC), Washington, D. C.). Aug 1973. 146p. (DOCKET-50425-21; DOCKET-50426-21; DOCKET-50427-21). Dep. NTIS $9.30.

20497 (DOCKET-50438-11) BELLEFONTE NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Tennessee Valley Authority, Chattanooga). 12 Jul 1973. 654p. (DOCKET-50439-11). Dep. NTIS $34.75.

Changes concerning the description of the facility, site characteristics, design criteria, engineered safety features, instrumentation and control, auxiliary systems, steam and power conversion, radioactive waste management, conduct of operations, technical specifications and quality assurance are presented. Responses for additional information, as requested by the AEC, are supplied as a supplement to the Draft Environmental Statement. (FS)

20498 (DOCKET-50440-17) PERRY NUCLEAR POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Cleveland Electric Illuminating Co., Ohio). 18 Jul 1973. 743p. (DOCKET-50441-17). Dep. NTIS $39.25.

Design changes made by the applicant and responses to AEC questions on the facility, site characteristics, design criteria, engineered safety features, instrumentation and control, auxiliary systems, steam and power conversion system, gaseous radioactive waste management, radiation protection, and accident analysis are presented. (FS)

20499 (DOCKET-50443-1) SEABROOK STATION, UNITS 1 AND 2. License Application and General Information, Volume 1. (Public Service Co. of New Hampshire, Seabrook (USA)). 30 Mar 1973. 563p. (Docket-50444-1). Dep. NTIS $30.25.

General information, including the financial statements and annual reports, is presented for the 22 applicants for licenses and permits required for the construction and operation of the facility. The information is furnished pursuant to 50.33 of the Commission's Rules and Regulations. (FS)

20500 (DOCKET-50443-2) SEABROOK STATION, UNITS 1 AND 2. License Application and General Information, Volume 2. (Public Service Co. of New Hampshire, Seabrook (USA)). 30 Mar 1973. 583p. (Docket 50444-2). Dep. NTIS $31.25.

Information, requested by the Attorney General for the antitrust review, is furnished by the 22 applicants as part of the Construction Permit application. (FS)

20501 (DOCKET-50443-3) SEABROOK STATION, UNITS 1 AND 2. Environmental Report, Volume 1. (Public Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 519p. (Docket-50444-3). Dep. NTIS $28.00.

The environmental effects of construction and operation of the Seabrook Station, Units 1 and 2 are examined. The descriptions include: the environment in the area, including the history, geography, geology, hydrology, climatology, ecology, land and water use including chemical characteristics; the facility and its effluents; and the impacts from construction and operation of the facility. (FS)

20502 (DOCKET-50443-4) SEABROOK STATION, UNITS 1 AND 2. Environmental Report, Volume 2. (Public Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 494p. (Docket-50444-4). Dep. NTIS $26.75.

Environmental effects of plant operation and accidents, effluent and environmental measurements and monitoring programs, economic and social effects of plant and construction and operation, alternate energy sources and sites, plant design alternatives, benefit-cost analysis, and environmental approvals and consultations are described. (FS)

20503 (DOCKET-50443-5) SEABROOK STATION, UNITS 1 AND 2. Environmental Report, Volume 3. (Public Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 490p. (Docket-50444-5). Dep. NTIS $26.50.

Appendices are presented which describe mammal and botanical surveys; a bird inventory; check lists of reptiles and amphibia; studies on condensing water, site, and thermal discharges; meteorological data; land planning and site design; power load and capacity; a buoyant jet discharge model; and radioactive source term information. (FS)

20504 (DOCKET-50443-7) SEABROOK STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 2. (Public Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 558p. (Docket-50444-7). Dep. NTIS $30.00.

Hydrologic engineering, geology, and seismology of the site are presented. Information on meteorology data, a glossary of terms used, geologic bedrock logs of site borings, a seismic survey, earthquakes which have affected the site, and static and dynamic rock properties is included in the appendices. (FS)

20505 (DOCKET-50443-8) SEABROOK STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 3. (Public Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 342p. (Docket-50444-8). Dep. NTIS $19.25.

The design criteria for structures, components, equipment, and systems; the mechanical, nuclear, thermal, and hydraulic design of the reactor; and the reactor cooling system are presented. (FS)

20506 (DOCKET-50443-9) SEABROOK STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 4. (Public

Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 468p. (Docket-50444-9). Dep. NTIS $25.50.

Engineered safety systems including containment, ECCS, and feedwater; instrumentation and controls; on- and off-site electric power; and auxiliary systems are described. (FS)

20507 (DOCKET-50443-10) SEABROOK STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 6. (Public Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 366p. (Docket-50444-10). Dep. NTIS $20.50.

The steam and power conversion system including the turbine-generator and the main steam supply system; radioactive waste management of gaseous, liquid, and solid wastes, process, effluent, and off-site monitoring programs; radiation protection including shielding, ventilation, and the health physics program; and the conduct of operations concerning personnel organization, training, and emergency planning are explained. (FS)

20508 (DOCKET-50443-11) SEABROOK STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 6. (Public Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 342p. (Docket-50444-11). Dep. NTIS $19.25.

Initial tests and operation, accident analysis, preliminary technical specifications, and the quality assurance program are presented. Responses to AEC questions concerning the plant description; site characteristics; design criteria for structures, components, equipment, and systems; the reactor coolant system; engineered safety features; auxiliary systems; radioactive waste management; radiation protection; conduct of operations; accident analysis; and quality assurance are given. (FS)

20509 (DOCKET-STN-50437-1) OFFSHORE POWER SYSTEMS. Plant Design Report, Vol. 1. (Offshore Power Systems, Jacksonville, Fla. (USA)). 1 May 1973. 528p. Dep. NTIS $28.50.

A general description and the plant-site interfaces for the standardized Floating Nuclear Plants are presented. Containment consists of a freestanding steel structure with an ice condenser and a separate concrete shield building with an annulus filtration system. The PWR reactors are rated at a net core power output of 3411 MW(t) plus 14 MW(t) from non reactor sources. The Engineering Safety Features design rating for each unit will be 3579 MW(t). Plant-site interfaces include design basis storm surge, maximum and minimum water depths, wind and wave conditions, geology and seismology, mooring, environment offsite radiation exposure, and site hazards. (FS)

20510 (DOCKET-STN-50437-2) OFFSHORE POWER SYSTEMS. Plant Design Report, Vol. 2. (Offshore Power Systems, Jacksonville, Fla. (USA)). 1 May 1973. 845p. Dep. NTIS $44.25.

Design criteria for components, systems, and structures including: wind and tornado effects; wave effects during towing and operation, missile protection, and protection against the dynamic effects of a LOCA are presented. Appendices describe the computer programs used in the analysis of structures, components, and systems; codes and standards; guidelines for combining events and loads in design; and a list for locating information relating to safety guides. (FS)

20511 (DOCKET-STN-50437-3) OFFSHORE POWER SYSTEMS. Plant Design Report, Vol. 3. (Offshore Power Systems, Jacksonville, Fla. (USA)). 1 May 1973. 443p. Dep. NTIS $24.25.

The mechanical, nuclear, and thermal design of the reactor, the reactor coolant system including pumps, steam generator, RHR system, pressurizers, valves, and piping; the engineered safety systems; instrumentation and controls; and the onsite and offsite electric power supplies are described. (FS)

20512 (DOCKET-STN-50437-4) OFFSHORE POWER SYSTEMS. Plant Design Report, Vol. 4. (Offshore Power Systems, Jacksonville, Fla. (USA)). 1 May 1973. 806p. Dep. NTIS $42.50.

Auxiliary systems including fuel, water, process auxiliaries, air conditioning, heating, and cooling; the steam and power conversion system which includes turbines, generators, main steam lines, and condensers; waste management for solid, liquid, and gaseous wastes, and process effluent monitoring are described. (FS)

20513 (DOCKET-STN-50437-5) OFFSHORE POWER SYSTEMS. Plant Design Report, Vol. 5. (Offshore Power Systems, Jacksonville, Fla. (USA)). 1 May 1973. 727p. Dep. NTIS $38.50.

Radiation protection, conduct of operations, initial tests and operation, accident analysis, technical specifications, and the quality assurance program are described. (FS)

20514 (DOCKET-STN-50437-6) OFFSHORE POWER SYSTEMS. Environmental Report, Supplement to Manufacturing License Application. (Offshore Power Systems, Jacksonville, Fla. (USA)). May 1973. 266p. Dep. NTIS $15.50.

The environmental effects of manufacturing the Platform Mounted Nuclear Plants on Blount Island are explained. The descriptions include basic relevant information concerning the physical and biological characteristics of the area that might be affected by operating the manufacturing facility; the manufacturing facility; environmental effects of facility operation; economic and social effects such as employment and taxes; alternatives; and cost benefit analysis. (FS)

20515 (DOCKET-STN-50437-7) OFFSHORE POWER SYSTEMS. Application for Manufacturing License and Supplemental Information. (Offshore Power Systems, Jacksonville, Fla. (USA)). May 1973. 517p. Dep. NTIS $27.75.

The financial qualifications and the annual reports are presented for the applicants for a license for a facility to manufacture Platform Mounted Nuclear Plants. (FS)

20516 (DOCKET-STN-50447-1) GENERAL ELECTRIC STANDARDS SAFETY ANALYSIS REPORT, BWR/6. Preliminary Safety Analysis Report, Volume 1. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 26 Jul 1973. 396p. Dep. NTIS $22.00.

A standard 3579 MW(t) boiling water reactor nuclear plant is described including the nuclear steam supply system, design criteria, and site envelope parameters chosen to permit utilization of the standard design in most of the United States. Those portions of the Standard Format not addressed by the General Electric Standard Safety Analysis Report (GESSAR) are identified and will be addressed by the applicants for specific plants. (FS)

20517 (DOCKET-STN-50447-2) GENERAL ELECTRIC STANDARDS SAFETY ANALYSIS REPORT, BWR/6. Preliminary Safety Analysis Report, Volume 2. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 26 Jul 1973. 468p. Dep. NTIS $25.50.

The design criteria of seismic category 1 structures, mechanical systems and components, seismic and environmental design of category 1 instrumentation and electrical equipment, separation criteria for safety related mechanical and electrical equipment, and the mechanical, nuclear, thermal, and hydraulic design of the reactor are presented. (FS)

20518 (DOCKET-STN-50447-3) GENERAL ELECTRIC STANDARDS SAFETY ANALYSIS REPORT, BWR/6. Preliminary Safety Analysis Report, Volume 3. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 26 Jul 1973. 384p. Dep. NTIS $21.25.

The reactor coolant system and the engineered safety features are described. (FS)

20519 (DOCKET-STN-50447-4) GENERAL ELECTRIC STANDARDS SAFETY ANALYSIS REPORT, BWR/6. Preliminary Safety Analysis Report, Volume 4. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 26 Jul 1973. 359p. Dep. NTIS $20.00.

The design of safety related and power generation systems including the reactor trip system, engineered safety features systems, and the safe shutdown systems is described. (FS)

20520 (DOCKET-STN-50447-5) GENERAL ELECTRIC STANDARDS SAFETY ANALYSIS REPORT, BWR/6. Preliminary Safety Analysis Report, Volume 5. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 26 Jul 1973. 470p. Dep. NTIS $25.50.

Systems required for safety and power generation; control systems; offsite and onsite power systems; auxiliary systems including fuel storage and handling, water systems, process auxiliaries, and environmental systems; and the steam and power conversion systems are described. (FS)

20521 (DOCKET-STN-50447-6) GENERAL ELECTRIC STANDARDS SAFETY ANALYSIS REPORT, BWR/6. Preliminary Safety Analysis Report, Volume 6. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 26 Jul 1973. 437p. Dep. NTIS $24.00.

Radwaste management, radiation protection, conduct of operations, initial tests and operation, and accident analysis are described. (FS)

20522 (DOCKET-STN-50447-7) GENERAL ELECTRIC STANDARDS SAFETY ANALYSIS REPORT, BWR/6. Preliminary Safety Analysis Report, Volume 7. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 26 Jul 1973. 324p. Dep. NTIS $18.25.

Technical specifications including safety limits and limiting safety system settings, limiting conditions for operations and surveillance requirements, major design features, and administrative controls; quality assurance during design and operation; a glossary; and plant nuclear safety analysis are presented. (FS)

20523 STANDARDIZED PLANTS: BOON OR BANE. Ward, J. E. (Sargent and Lundy, Chicago). Nucl. News; 16: No. 10, 51-56(Aug 1973).

Information is presented concerning the possibilities of establishing standardized systems for nuclear power plants. The effects of standardized systems on the licensing time for nuclear power plants are analyzed. (DCC)

20524 IMPORTANT CONSIDERATIONS WITH RESPECT TO THE DEVELOPMENT AND USE OF OPERATING PROCEDURES BY NUCLEAR POWER PLANT STAFF PERSONNEL. Keppler, J. G. (Atomic Energy Commission, Washington, DC). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 1(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20525 QUEST FOR PLANT SAFETY THROUGH OPERATING PROCEDURES. Bitel, J. (Commonwealth Edison Co., Zion, IL). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 1-2(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20526 IMPACT OF STANDARDS AND CRITERIA ON NUCLEAR OPERATING ORGANIZATIONS AND PROCEDURES. Noble, D. M.; Gibson, L. S. (Consumers Power Co., Jackson, MI). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 4(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20527 OPTIMUM NUCLEAR POWER PLANT OPERATOR SELECTION AND TRAINING. Elliot, N. S. (Babcock and Wilcox Co., Lynchburg, VA); Thomas, E. L. Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 19(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20528 EXPERIENCE WITH OPERATOR CANDIDATE SELECTION. Kaiz, G. H. (NUS Corp., Rockville, MD). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 19-20(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20529 ON-SITE SYSTEMS TRAINING AND OPERATOR REQUALIFICATIONS: A COMBINED APPROACH. Lobbin, F.; Roth, D. R. (General Physics Corp., Columbia, MD). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 20-21(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20530 ELECTRICITY AND ELECTRONICS COURSE FOR NUCLEAR INSTRUMENTATION AND CONTROL TECHNICIANS. Bacharach, S. L. (General Physics Corp., Columbia, MD); Burdette, R. E. Jr.; Stalter, L. Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 21-22(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20531 FINAL PREPARATION FOR THE COLD-LICENSE AEC EXAMINATION. Roth, D. R. (General Physics Corp., Columbia, MD); Kirby, J. E. Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 22-23(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20532 NUCLEAR PLANT INSTRUCTORS: SELECTION AND DEVELOPMENT. Kaiz, G. H.; Schmidt, W. J. (NUS Corp., Rockville, MD). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 23-24(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

20533 SIMULATION STANDARDS: THE TRAINING VIEW. Cox, A. C.; Hughes, T. E. C. (Singer Co., Silver Springs, MD). Trans. Amer. Nucl. Soc., Suppl.; 17: No. 1, 24(1973).

From conference on reactor operating experience; Myrtle Beach, South Carolina, USA (5 Aug 1973). See CONF-730819-.

GENERAL

Civilian Defense

20534 SPRING MEETING OF THE WESTERN STATES SECTION/THE COMBUSTION INSTITUTE, APRIL 16-17, 1973, TEMPE, ARIZONA. Tempe, AR; Western States Section/The Combustion Institute (1973). 496p. (CONF-730453-).

A separate abstract was prepared for one paper. Nineteen additional papers discuss various aspects of combustion and fire retardation. (CH)

For an abstract of an individual section see: 20535.

20535 FLAMBEAU IN RETROSPECT. Countryman, C. M. (Pacific Southwest Forest and Range Experiment Station, Berkeley, CA). pp vp Paper 1 of Spring Meeting of the Western States Section/The Combustion Institute. Tempe, AZ; Western States Section/The Combustion Institute (1973).

From spring meeting western states section/The Combustion Institute; Tempe, Arizona, USA (16 Apr 1973). See CONF-730453-.

Project Flambeau was an investigation of mass fire undertaken by the Pacific Southwest Forest and Range Experiment Station, and supported in part by U. S. Department of Defense agencies. Primary purpose of the study was to gain insight into as many aspects of mass fire as possible under various fuel and weather conditions. This information was needed for the development of a prescription for mass fires so as to assure such fires for multimillion dollar fire tests planned by Civil Defense to evaluate civilian fire hazards and countermeasures in case of nuclear attack. Other objectives were to explore instrumentation needs in the study of mass fires, to build a data bank of information on mass fires, and to test a descriptive model of a mass fire system. As a result of the study, which included a series of experimental free-burning fires, it was possible for the first time to specifically define mass fire, describe its characteristics, set the boundary conditions for fire size and energy production needed for a mass fire, and to prescribe the required fuel-bed conditions. Under the same circumstances and for the same purpose, a similar approach as used in Project Flambeau would probably be necessary today. But the same amount of effort spread over a longer time period, and the use of experimental fires to verify and test hypotheses and theories would lead to greater progress in the understanding of mass fires. In the study of urban mass fires, additional experimental fires are likely to be needed. For the wildland situation where the conflagration type mass fire is the primary problem, emphasis should be on the investigation of wildland fuel characteristics and the development of techniques for fuel modification and management as a means of inhibiting the development of mass fires. (auth)

Energy Utilization and Economics

20536 (COO-3028-6) PADRE SOL AND CHEMICAL FUEL PRODUCTION. Axtmann, R. C. (Princeton Univ., N. J.). [nd]. Contract AT(11-1)-3028. 13p. (CONF-730646-1). Dep. NTIS $3.00.

From science and man in the Americas conference; Mexico City, Mexico (20 Jun 1973).

The problem of energy storage during the periods of night or cloud cover is considered, and it is suggested to combine the electrical power plant with a chemical fuel plant: a portion of the solar energy would be used to electrolyze water to produce hydrogen fuel. Another use of solar energy is in the production of fuels from organic wastes and plants; a continuous unit for converting organic material to methane gas in an anaerobic fermentation step is illustrated. Two other possibilities are also considered briefly: biophotolysis of water to produce hydrogen and enzymatic reduction of organic materials to clean fuels. Finally, a brief comparison is made between the costs of present-day fuels and solar-derived fuels. 4 figures. (DLC)

20537 (HN-8145.3(Vol. 1)) CALIFORNIA POWER PLANT SITING STUDY. Executive Summary. (Holmes and Narver, Inc., Anaheim, Calif. (USA); Dames and Moore, Los Angeles, Calif. (USA)); May 1973. 56p. Dept. of Conservation, Sacramento, CA $3.00.

The study was conducted to assist the State of California in the development of long range plans for siting of electric power generating plants in coastal zones and inland locations. Factors that influence siting decisions for nuclear and fossil-fuel power plants are sources of large quantities of cooling water and close proximity to load centers. Among the environmental factors where proper planning is essential is the matter of reject heat from the plant. There are many other factors of importance when seeking an acceptable power plant site. First, the coastline of California is a particularly desirable location for many other uses; namely, recreational, residential, or industrial uses. The construction of contemporary nuclear power plants may have an impact on nearby areas more suitable for other uses. Second, after investigations at specific locations, it might be shown that sites are unsuitable for the contemporary power plants and that alternative plant siting concepts would result in more acceptable conditions. (MCW)

20538 (HN-8145.4(Vol. 2)) CALIFORNIA POWER PLANT SITING STUDY. (Holmes and Narver, Inc., Anaheim, Calif. (USA) Dames and Moore, Los Angeles, Calif. (USA)). May 1973. 293p. Dept. of Conservation, Sacramento, CA $5.00.

The next generation of major power plants in California must utilize nuclear fuel to obtain thermal energy. Approximately ten years are required to establish nuclear power facilities from the time sites are selected and environmental studies are begun. Volume I presented an executive summary of the power plant siting study and, now, Volume II contains an expanded discussion on power plant siting. Siting factors and the study scope are presented. The expanded discussion includes all aspects of coastal siting, inland siting, siting concepts, alternative power systems, and concepts evaluation. Conclusions and recommendations are summarized. (MCW)

20539 (HN-8145.5(App.)(Vol. 3)) CALIFORNIA POWER PLANT SITING STUDY. (Holmes and Narver, Inc., Anaheim, Calif. (USA); Dames and Moore, Los Angeles, Calif. (USA)). May 1973. 154p. Dept. of Conservation, Sacramento, CA $3.00.

This volume contains 4 appendixes, Appendix A being a bibliography of 375 references, with 66 papers cited from the American Nuclear Society Transactions. Appendix B is alternative reactor systems: aspects of siting pressurized water or boiling water reactor systems are discussed; one HTGR system is producing heat for steam generators, one soon will be, and several others are in the engineering phase in California; and siting of the LMFBR is discussed because of its basic differences in the primary heat transfer loop and because it is the breeder concept selected by the United States AEC for initial demonstration of commercial feasibility. Evaluation methodology and evaluation data are discussed and summarized in Appendixes C and D, respectively. (MCW)

20540 (LA-UR-73-715) LOGISTICS, ECONOMICS, AND SAFETY OF A LIQUID HYDROGEN SYSTEM FOR AUTOMOTIVE TRANSPORTATION. Stewart, W. F.; Edeskuty, F. J. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 31p. (CONF-730917-1). Dep. NTIS $3.75.

From intersociety conference on transportation; Denver, Colorado, USA (24 Sep 1973).

A hydrogen-powered automobile plays a prominent role in many of the proposed solutions for the energy crisis. The development of a hydrogen powered automobile involves the development of a hydrogen-fueled engine, a hydrogen storage system on-board the vehicle, and a hydrogen production and distribution system. Several design aspects, cost estimates, and safety considerations are discussed for a liquid hydrogen production and distribution system. The amount of liquid hydrogen that must be produced annually to replace the gasoline consumed by automobiles is estimated. This estimate includes boiloff, cooldown, and transfer losses from the production plants, transport trailers, service stations, and automobiles. (7 tables, 4 figures, 40 references) (auth)

20541 (ORNL-EIS-73-52(Vol. 1)(No. 6)) NSF-RANN ENERGY ABSTRACTS. A Monthly Abstract Journal of Energy Research. Guthrie, M. P. (ed.). (Oak Ridge National Lab., Tenn.). Jun 1973. Contract W-7405-eng-26. 123p. Dep. NTIS $8.25.

The energy bibliography covers research on energy sources, electric power (generation, supply and demand, transmission, environmental effects, and use), and energy (production, consumption, supply and demand, and policy). The research publications cited are technical journal articles, popular or semi-technical magazine articles, topical reports, progress reports, symposium papers and proceedings, monographs, and books published within the past two years. This issue contains indexes to "NSF–RANN Energy Abstracts," Volume 1, Numbers 1 through 6 on subject category, keywords, authors, corporate authors, and permuted titles. A total of 164 abstracts are included. (MCW)

20542 (ORNL-NSF-EP-51) RESIDENTIAL CONSUMPTION OF ELECTRICITY: 1950–1970. Tansil, J. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 35p. Dep. NTIS $3.75.

The growth of residential electricity use between 1950 and 1970 is examined on the basis of increases in the number of households, number of appliances, and the average annual electricity consumption per appliance. Increased electricity use per household accounted for 73% of the growth of residential electricity consumption, while 27% of the growth was due to an increase in the number of households. Consumption patterns are defined that illustrate the factors accounting for the increase from 1800 kWh per household in 1950 to 7000 kWh per household in 1970. The greatest potential for more efficient energy use occurs through insulating houses better, shifting from electric resistance heating to heat pumps, using more efficient air conditioners, substituting fluorescent for incandescent lighting, and improving insulation for refrigerators, freezers, and water heaters. Immediate implementation of these energy conservation measures would result in a 30 to 40% reduction in residential electricity consumption. The number of households, number of appliances, and average annual electricity use per appliance are projected to 1990 to obtain the total electricity consumption per appliance. The sum of the disaggregated projections is compared to other independent projections based on extrapolation and econometric methods. (auth)

20543 (SLA-73-207) HEAT TRANSMISSION BY HOT WATER THROUGH LONG PIPELINES. Thunborg, S. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 15p. Dep. NTIS $3.00.

The basic equations relating to the cost and effectiveness of transmitting heat over long distances through hot-water pipelines are derived. It gives an insight into the problems associated with hot-water heat transmission. Further, it applies these equations to a 200-mile pipeline and concludes that such a system is not yet cost effective in relation to today's fossil fuel prices. (auth)

20544 (UCID-16317) SOLAR PONDS EXTENDED. Clark, A. F. (California Univ., Livermore. Lawrence Livermore Lab.). 27 Jul 1973. Contract W-7405-eng-48. 12p. Dep. NTIS $3.00.

An effort was made to find and develop a system to produce electrical power from solar energy. The largest item of cost in a solar energy system is the collector, and a solar pond can be made very cheaply compared to mirrors or metal collectors or multilayered glass systems. The heat can be transported by, stored in, and extracted from water very readily and relatively inexpensively. The present concepts feature a shallow pond that is quickly and readily heated and can be emptied at night, cutting down on the thermal losses. The pond would be filled only when the solar radiation is strong enough to heat the water. The rest of the time the water would be stored in a large insulated reservoir, thus providing as much heat energy storage as desired and certainly enough to last more than a day or so. Calculations indicate that a thermodynamic cycle using some fluid other than water could be more efficient in extracting power. A Freon 11 liquid–vapor system could be the appropriate fluid to run the turbine and generate electricity. Waste heat could be disposed of in a water cooling tower. (MCW)

20545 WATER RESOURCES AND WASTE HEAT. Olds, F. C. Power Eng.; 77: No. 6, 26-33(Jun 1973).

Estimates of the world water supply are presented and the distribution of precipitation in the U.S. into principal flows and uses, including steam electric power generation, is discussed. It is pointed out that geographical location plays a role in the possible industrial and utility uses of fresh water supplies and that the heat-holding capability of water has an impact on air temperature and energy consumption in urban areas. It is concluded that U.S. water supplies are adequate to handle waste heat for decades but the supply is not always located or timed conveniently. The impact of economic, political, and sociological factors on decisions as to power supplies and cost factors regarding pollution control is discussed. (CH)

20546 TEXAS AND NUCLEAR POWER. Johnson, P. C. (Texas Medical Center, Houston). Tex. Med.; 69: 81-85(Mar 1973).

Texas must look for new sources of electric power to prevent an energy crisis. Nuclear power is the most practical of the new forms of electricity. The proposal of a nuclear power plant generates considerable controversy among the citizens of the community. Much debate centers around the medical consequences of the released radioactivity. The practicing physician can help his community resolve the problem. This review is designed to give the Texas physician the information necessary to answer his patients' questions concerning nuclear power. (auth)

20547 SOVIET UNION PLANS INTEGRATED POWER SYSTEM. Falaleev, P. Energy Int.; 10: No. 6, 23(Jun 1973).

The output of electricity in the Soviet Union will increase to 1,065 TWh and the total capacity of power stations to 231 to 233 GW during the Ninth Five-Year Plan (1971-1975). The capacity of fuel power stations has been increased largely by installing big power units with a total capacity of 7.2 GW, including 5.3 GW of units working on supercritical parameters. By January 1, 1972 over 260 operating units had capacities ranging from 150 to 800 MW, while the total generating capacity of thermal turbines was over 45 GW. Nuclear stations with reactors of 1,000 MW and more are to be built mainly in the European sector where fuel sources are limited. More generating capacities will become operational at the Novovoronezhskaya, Leningrad, Kolsky, and Chernobylskaya nuclear power stations. Construction work is in progress on two nuclear stations in the Ukraine. Many new hydro stations are due for completion during the current period. The Sayan power station will be the largest hydro station ever, with a capacity of over 6.4 GW. A single power system of the USSR, integrating 53 power stations of European Russia and the Urals, is the world's biggest power station controlled from a single center. (MCW)

20548 HERE COMES THE SUN. Kenward, M. New Sci.; 59: No. 854, 71-72(12 Jul 1973).

There are many technological possibilities for solar energy. Most of them are well enough understood to convince all but the most skeptical that the Sun can contribute significantly to man's energy supplies. The question is, can these technologies be developed so that the energy is available at a reasonable price. The fuel for a solar power plant is free, but the capital cost can be very high to turn the Sun's radiation into electricity, hot water, distilled water, cold air, etc. The feasibility of harnessing solar radiation is not in doubt, but before we can plug into the Sun many technical questions still have to be answered. Problems discussed include size, collector design, weather dependency, use of satellite systems, and storage problems. (MCW)

20549 PROCEEDINGS OF THE EFFECTIVE ENERGY UTILIZATION SYMPOSIUM, PHILADELPHIA, PENNSYLVANIA, JUNE 8–9, 1972. Philadelphia; Drexel University (1972). 305p. (CONF-720690--).

Fifteen papers dealing with various aspects of energy utilization from developments to the problems confronting the utilities and the consumer were presented. New effective energy utilization aspects include societal and environmental costs. Systems now designed will meet composite goals of energy efficiency, financial return, resource conservation, peak load capability, and new standards for environmental and social impact, aesthetics, and public acceptability. (MCW)

20550 CONSERVATION: A POSITIVE POSITION. Clement, R. C. IEEE (Inst. Elec. Electron. Eng.), Spectrum; 10: No. 8, 44-47(Aug 1973).

Correlations exist between increasing consumption of electricity and the high-consumption society that exists in the last generation. The price tag of progress—rising pollution, deteriorating cities, the disappearance of amenities in the countryside, social unrest, and alienation—is discussed as seen by the engineers: view and those who refute it. In 1969, assumptions that had existed since WW II became useless. These observations were that prices would remain relatively constant, fuel would remain generally available, Government policy would remain relatively unchanged, and there would be gradual technological improvement in energy production. Environmentalists insist on a policy that requires the full economic and social costs of energy on the consumers of energy and the adequate environmental safeguards on the producers and distributors of this energy, the elimination of economic subsidies to energy industries for doing what small business does without in response to public demand for goods at a fair price; performance standards on the building industry and the manufacturers of energy-consuming equipment to eliminate the wasteful build-in obsolescence characteristic of so much production in the US today with the existing inefficiencies; and a shift in transportation policies from inefficient huge automobiles and intercity trucks and aircraft to more efficient railroads, buses. (MCW)

20551 AUSTRALIA PLANS ENERGY POLICY. 10: No. 8, 10-12(Jun 1973).

The Australian Federal Government has announced plans to develop energy resources on a national scale and to conserve offshore oil and gas reserves in the national interest. It was announced that the Federal Government will build a national gas pipeline system, and is expected to cost about $A1200 million. The first stage linking Sydney with the Gidgealpa gas fields in South Australia will cost $A190 million and will eventually service Wollongong, Port Kembla, and the Albury–Wodonga growth center, as well as Melbourne, Perth, and Brisbane. It will be linked to the Palm Valley field in the Northern Territory, and travel across

Australia to tap the rich off-shore resources of the north–west shelf. The pipeline route will also cross and serve the Pilbara mining region, and there will be a secondary line to the Northern Territory. The Federal Government announced plans to set up a national petroleum and minerals authority to search for oil. The creation of a Fuel and Energy Authority is proposed. The attitudes behind the policy and some of the plans in the major utilities are examined. (MCW)

20552 SOLAR ENERGY FOR MAN. Brinkworth, B. J. Halsted Press Book. New York; John Wiley and Sons, Inc. (1972). 261p. $8.95.

Ways of coping with the power needs in view of growing populations and lagging development are investigated. Most of the world's energy has come from the energy stored in fossil fuels, but the exhaustion of these stocks is foreseeable and other sources must be considered. Nuclear plants can be expected to meet the large-scale demand in the long term. Solar energy is plentiful in those countries most urgently needing power and is suitable for small, local demands in isolated places. Solar energy for Man contains 10 chapters: Energy and the Human Condition; The Sun and the Earth; A Review of First Principles; Collection of Solar Energy; Heating by Solar Energy; Conversion of Solar Energy into Work; Conversion of Solar Energy into Electricity; Photoelectricity; Photochemistry and Photobiology; and the Introduction of Solar Power. (MCW)

20553 OCEAN TEMPERATURE GRADIENTS: SOLAR POWER FROM THE SEA. Metz, W. D. Science; 180: No. 4092, 1266-1267(22 Jun 1973).

Warm ocean water in the tropics moves toward the poles, and ice melts. Cold water at the poles slides into the depths of the oceans and slowly moves toward the equator. In the tropics this cold water provides a nearly infinite heat sink at about 5 C at a depth as shallow as 1000 m. Both the hot surface water and the cold deep water are replenished by solar energy. The temperature differentials in the tropics are not large, but can be used to generate electricity. Far more energy than that consumed throughout the world is potentially available from the seas. In 1964, Hilbert Anderson and James Anderson of York, Pennsylvania, suggested the economic viability of a power plant operated by the ocean thermal gradient. The thermal efficiency of an ocean gradient power plant is low, but the heat exchanger walls may be made thin making it economically feasible. In addition to electricity, an ocean thermal gradient plant could produce fresh water, and hydrogen and oxygen through electrolysis of water. Another product of the plant is food. The artificial upwelling necessary to provide cold water from an ocean gradient plant could be used to cultivate algae, crustaceans, and shellfish. One of the natural upwellings in the Humboldt current off Peru supplies almost one-fifth of the world's fish harvest. Transmission of power from the tropics is not feasible, but the Gulf Stream carries enough warm water to supply the nation's power needs, even if inefficient solar sea power engines are used. Estimates are made of the environmental effects of the solar sea power plants. (MCW)

Information Handling

20554 (UCRL-74685) PROBLEMS AND SOME SOLUTIONS FOR THE CREATION AND UTILIZATION OF LARGE INTER-DISCIPLINARY COMPUTERIZED DATA BANKS. Hampel, V. E. (California Univ., Livermore. Lawrence Livermore Lab.). 1 Jul 1973. 21p. (CONF-730719-1). Dep. NTIS $3.25.

From the CODATA symposium on man-machine communication for scientific data handling; Greiburg, F.R. Germany (22 Jul 1973).

A review of the applied research in the computer environment at LLL is given. The MASTER CONTROL program for data utilization at the laboratory is briefly discussed along with the problems and solutions in the bibliographic and quantitative domains. (MOW)

20555 COOPERATIVE INFORMATION STORAGE AND RETRIEVAL SYSTEM FOR THE PETROLEUM INDUSTRY. Martinez, S. J. (Univ. of Tulsa, OK). J. Chem. Doc.; 13: No. 2, 59-65(May 1973).

The Petroleum Abstracts bulletin was first published in January 1961, as a cooperative information storage and retrieval service for the exploration, development, and production segment of the petroleum industry. Information retrieval from retrospective files was first accomplished by an inverted subject card file. In 1965, this system was replaced by controlled-vocabulary, subject indexing. Current under development is the PASS direct-access computer system (Petroleum Abstracts Search System) that allows real-time intercommunication with the disk-pack stored data base, through a telephone-linked portable teletype console. This system is designed to operate on a Xerox Sigma 6 computer. (auth)

20556 COMPUTERIZED SYSTEM COLLECTS CREEP DATA. Roberts, B. W.; Cullen, T. M. (Combustion Engineering Inc., Chattanooga). Metal Progr.; 104: No. 3, 47; 50-51(Aug 1973).

Creep-rupture data for heat-resistant alloys are collected and analyzed automatically by a complex acquisition and process control computer system. The information helps designers to analyze the behavior of pressure vessels and other components requiring durability at high temperatures. (auth)

Law

20557 LEGAL REQUIREMENTS FOR PERIODIC EXAMINATION OF PRESSURE VESSELS UNDER THE FACTORIES ACT 1961. Toogood, J. T. (H. M. Factory Inspectorate, London). pp 93-96 of Periodic Inspection of Pressure Vessels. London; Institution of Mechanical Engineers (1972).

From conference on periodic inspection of pressure vessels; London, England (9 May 1972).

The history leading up to the present legal requirements relating to periodic examination of pressure vessels under the Factories Act is traced. Its requirements are discussed and some questions are posed as to periodic examination in the future. (auth)

Mathematics and Computers

Refer also to abstracts 18752, 20015, and 20622.

20558 (AAEC/E-248) MACROS TO SIMULATE FORTRAN I/O IN ASSEMBLER PROGRAMS. Johnson, S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1972. 11p. Dep. NTIS (U. S. Sales Only) $3.00.

The AREAD, SWRITE, AFORMAT, ABACKSP, AREWIND, and AENDFILE instructions are described. They are analogous to the FORTRAN READ, WRITE, FORMAT, BACKSPACE, REWIND, and END FILE statements, respectively, and are intended for use by FORTRAN programmers when writing in the IBM System 360 assembler language. (auth)

20559 (AAEC/E-251) AESYNTAX: A FORTRAN SYNTAX ANALYSIS SYSTEM FOR THE PDP9L. Barry, J. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1972. 12p. Dep. NTIS (U. S. Sales Only) $3.00.

A facility is presented to assist FORTRAN programmers in the development of new programs by the immediate listing and syntax analysis of FORTRAN-coded source decks independently of the central computer. (auth)

20560 (AAEC/TM-623) PDPCOPY: AN INTERACTIVE PDP9L TAPE TRANSLATION AND ANALYSIS PROGRAM. Backstrom, R. P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1972. 13p. Dep. NTIS (U. S. Sales Only) $3.00.

A description is given of the teletype command language of PDPCOPY whose primary function is the conversion of BCD tape records into EBCDIC format for transmission across a Link from a PDP9L to an IBM360 computer. Records may be examined on a teletype in both character and hexadecimal format, listed on an Anelex line printer and blocked or unblocked for Link transmission. (auth)

20561 (AAEC/TM-633) AAEARITH: MULTIPLE PRECISION ARITHMETIC ROUTINES FOR THE IBM360 FORTRAN USER. Backstrom, R. P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1972. 11p. Dep. NTIS (U. S. Sales Only) $3.00.

AAEARITH is an IBM360 Assembler package which allows the Fortran user to perform 30-digit floating-point addition, subtraction, multiplication, and division. An example of the use of AAEARITH is given in HPOLRT which is a Fortran subroutine designed to solve high-order polynomial equations. (auth)

20562 (AECL-4210) REMES 2: A FORTRAN PROGRAM TO CALCULATE RATIONAL MINIMAX APPROXIMATIONS TO A GIVEN FUNCTION. Johnson, J. H.; Blair, J. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1973. 85p. Dep. NTIS (U. S. Sales Only) $6.25. AECL $2.00.

REMES2, a double precision FORTRAN program designed to run on a CDC 6000 series computer, calculates rotational function minimax approximations (that is best approximations in the sense that the maximum error in the range is as small as possible) to a given continuous function. The precision obtainable ranges from 1 to 24 significant figures depending on the precision with which the function is specified. The program uses the second algorithm of Remes, combined with a starting algorithm based on a suggestion of Werner. Various options may be se-

lected by input parameters, to generate either single approximations or large segments of the Walsh array, and the resulting coefficients are automatically rounded off and tested for ill-conditioning. (auth)

20563 (AEEW-R-859) MATHEMATICAL MODEL OF A VAPOUR COMPRESSION DESALINATION PLANT. Guneratne, D. C. (Atomic Energy Establishment, Winfrith (England)). May 1973. 23p. Dep. NTIS (U. S. Sales Only) $3.25.

This report describes how a simplified model of a hybrid vapor compression/multi-effect distillation/multistage flash process was developed into a model for the design computer program, VACOMP. The code was written and tested, and is suitable for further development as knowledge of the process improves. (auth)

20564 (AEEW-R-860) DISTILLATION DESALINATION PLANTS: SIMPLIFIED MATHEMATICAL MODELS. Guneratne, D. C. (Atomic Energy Establishment, Winfrith (England)). May 1973. 48p. Dep. NTIS (U. S. Sales Only) $4.50.

This report describes the simplified models that were derived for representing various distillation processes, namely multiple-effect evaporation, vapor compression, and multistage flash. Application of an ordering algorithm shows that the models can be solved by means of a suitable choice of design variables and by using each equation of the model in turn to evaluate another variable. Various computer programs were written, based on these models. They were successfully tested, and demonstrate the feasibility of this type of approach. A feature of these programs is the short time required for execution, (about 1 second). They are very suitable, therefore, for use with future automatic optimization packages that may become available. (auth)

20565 (AEEW-R-861) MATHEMATICAL MODELLING OF THE MULTI-EFFECT EVAPORATION PROCESS FOR SEAWATER DISTILLATION PLANTS. Guneratne, D. C. (Atomic Energy Establishment, Winfrith (England)). May 1973. 24p. Dep. NTIS (U. S. Sales Only) $3.25.

This report describes the mathematical model that has been used to represent the multi-effect evaporation process, in the computer program MULTEFFECT, for purposes of constructing seawater distillation plant flowsheets. The more important equations are given in full, while the others are implied by a description of the factors to be considered. This approach removes the need to list numerous simply derived equations. (auth)

20566 (AERE-TP-430) RECENT ADVANCES IN UNCONSTRAINED OPTIMIZATION. Powell, M. J. D. (Atomic Energy Research Establishment, Harwell (England)). Nov 1970. 39p. Dep. NTIS (U.S. Sales Only) $4.00.

The development of algorithms and theory for the unconstrained optimization problem during the years 1967–1970 is surveyed. Therefore (except for one remark) the material is taken from papers that have already been published. This exception is an explanation of some numerical difficulties that can occur when using Davidon's (1959) variable metric algorithm. (53 references) (auth)

20567 (AERE-TP-431) AN EFFICIENT, GLOBALLY CONVERGENT, ALGORITHM FOR UNCONSTRAINED AND LINEARLY CONSTRAINED OPTIMIZATION PROBLEMS. Fletcher, R. (Atomic Energy Research Establishment, Harwell (England)). Dec 1970. 39p. Dep. NTIS (U.S. Sales Only) $4.00.

An algorithm for minimization of functions of many variables, subject possibly to linear constraints on the variables, is described. In it a subproblem is solved in which a quadratic approximation is made to the object function and minimized over a region in which the approximation is valid. A strategy for deciding when this region should be expanded or constructed is given. The quadratic approximation involves estimating the hessian of the object function by a matrix which is updated at each iteration by a formula reported by Powell (AERE-TP-382). This formula enables global convergence of the algorithm to be proved. Use of such an approximation, as against using exact second derivatives, also enables a reduction of about 60% to be made in the number of operations to solve the subproblem. Numerical evidence is reported showing that the algorithm is efficient in the number of function evaluations required to solve well-known test problems. (26 references) (auth)

20568 (ANL/ESP-2) GUIDE TO THE COMPUTER PRODUCTION OF RANDOMIZED EXAMINATIONS. Frigerio, N. A.; Stowe, R. S. (Argonne National Lab., Ill.). Jun 1973. 31p. Dep. NTIS $3.75.

With increasing crowding of classrooms and increased teaching loads, it becomes evermore difficult for the instructor to provide examinations that obviate the possibility of student transcription, and which are not too similar to previous examinations possibly in circulation, without going to forms that are either very difficult to write or difficult to grade. To aid some in this area, a program was produced for randomizing objective-type examinations, which is now in use in several nearby schools. This program is designed to minimize labor on the part of the instructor, both in preparation and in correction, while at the same time designing examinations so that breaches of security are rendered difficult. The program has been kept small enough to be used at schools with even the most modest computer facilities. (auth)

20569 (COO-1469-212) AUTOMATIC SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS. Larsen, L. A. (Illinois Univ., Urbana. Dept. of Computer Science). Oct 1972. Contract AT(11-1)-1469. 134p. (UIUCDCS-R-72-546). Dep. NTIS $8.75.

Thesis.

An automatic method that can be applied to some subset of partial differential equations is investigated. The primary value of a program involving an automatic method would be to provide the person who needs only a few runs with a particular type of equation the opportunity to find a solution, within acceptable tolerances, without having to write and debug a specialized program. (auth)

20570 (COO-1469-215) NUMERICAL SYSTEMS ON A MINICOMPUTER. Brown, R. L. Jr. (Illinois Univ., Urbana. Dept. of Computer Science). Feb 1973. Contract AT(11-1)-1469. 47p. (UIUCDCS-R-73-555). Dep. NTIS $4.50.

Thesis.

The concept of a numerical system is defined for a minicomputer and a description is given of the software and computer system configuration necessary to implement such a system. A procedure for creating a numerical system from a FORTRAN program is developed and an example is presented. The reader should have some knowledge of FORTRAN and minicomputer operating systems, PAL assembly language for PDP-11. (auth)

20571 (ITEF-934) STUDY OF SOME QUESTIONS OF THE SYNTHESIS OF THRESHOLD FUNCTIONS. Belyakov-Bodin, V. I.; Rozenblit, S. I. (Gosudarstvennyi Komitet po Ispol'Zovaniyu Atomnoi Energii SSSR, Moscow. Institut Theoreticheskoi i Eksperimental'noi Fiziki). 1972. 21p. (In Russian). Dep. NTIS (U.S. Sales Only) $3.25.

20572 (ITEF-946) EVALUATIONS OF APPROXIMATE SOLUTIONS OF INTEGRAL FREDHOLM EQUATIONS OBTAINED BY THE METHOD OF ACCELERATED CONVERGENCE AND BY THE METHOD OF AVERAGING FUNCTIONAL CORRECTIONS. Grebenikov, E. A.; Morozova, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only) $3.00.

There are discussed evaluations for norms in Banach spaces of exact differences and approximate solutions of integral Fredhom equations, obtained by the method of accelerated convergence and by the method of functional corrections. (tr-auth)

20573 (JEN-267) TWO PROGRAMS OF UTILITY IN THE PERFORMANCE OF HISTOGRAMS AND DALITZ PLOTS BY MEANS OF A CALCOMP-563 PLOTTER. Carcedo, A.; Ladron de Guevara, P. (Junta de Energia Nuclear, Madrid (Spain)). 1973. 73p. (In Spanish). Dep. NTIS (U. S. Sales Only) $5.75.

Full description of the whole structure and of the operation of every routine is given for both programs, as well as the data setup in punched cards and binary tape. To help the users several examples of data sets and the corresponding output plots are described. The list of instructions in FORTRAN IV language is included. The same version of both programs is operative in the series 7090-94-IBM and 1106-08-UNIVAC. (auth)

20574 (KFK-1722) DESIGN PRINCIPLES OF THE GRAPHIC SYSTEM. Enderle, G.; Schlechtendahl, E. G.; Schumann, U.; Schuster, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). May 1973. 129p. Dep. NTIS (U.S. Sales Only) $8.50.

GRAPHIC is a system for handling graphical information. It allows definition, management, and output of graphical objects. The main components of the GRAPHIC system are: (1) a problem-oriented language for specification of graphical objects and of operations to change them; the language contains subroutines, DO-, and IF-statements; (2) a language interpreter which builds up a data structure while analyzing the statements of the language; (3) a data structure for the internal representation of graphical objects and operations as nodes in a hierarchical ring structure; and (4) routines for parsing structures of graphical objects, for executing operations, creating new objects and for output of graphical information. Language and data structure allow referencing of objects by name. GRAPHIC has been implemented as a subsystem of the CAD-system ICES. (auth)

20575 (LA-5146) NUMERICAL CALCULATION OF SURFACE WAVES: A MODIFIED ZUNI CODE WITH SURFACE PARTICLES

AND PARTIAL CELLS. Amsden, A. A. (Los Alamos Scientific Lab., N. Mex.). May 1973. Contract W-7405-eng-36. 18p. Dep. NTIS $4.00.

Extensions to the original Simplified Marker-and-Cell (SMAC) method computing program, ZUNI, are described. These include Nichols and Hirt's improved free-surface treatment and, in addition, a partial-cell treatment that allows an obstacle face to pass through cell diagonals. Applications of the modified program are shown by calculations of wave runup on both submerged and exposed sloping beaches. The validity of the approach for studies of actual tsunami waves was demonstrated. (auth)

20576 (LA-UR-73-91) TWO-DIMENSIONAL FLOW OF DETONATIONS PROCEEDING PERPENDICULAR TO CONFINED AND UNCONFINED SURFACES. Mader, C. L. (Los Alamos Scientific Lab., N. Mex.). 1973. 19p. (CONF-730702-1). Dep. NTIS $3.00.

Plane-wave-initiated detonation waves proceeding perpendicular to a confined or unconfined surface exhibit very little wave curvature and a complicated flow pattern behind the wave. Numerical studies of this process were performed using a two-dimensional Lagrangian code, 2DL, to solve the reactive hydrodynamics. (auth)

20577 (LA-UR-73-918) COMPARATIVE EFFICIENCY OF CERTAIN FINITE-ELEMENT AND FINITE-DIFFERENCE METHODS FOR A HYPERBOLIC PROBLEM. Swartz, B.; Wendroff, B. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 13p. (CONF-730713-1). Dep. NTIS $3.00.

From conference on the numerical solution of differential equations; Dundee, UK (3 Jul 1973).

The notion of the resolving power of approximation methods, i.e., the number of intervals (or function values) per wavelength necessary to attain a preassigned error when approximating a given frequency permits evaluation of the comparative efficiency of three types of space differencing used in setting up differential difference equations for the hyperbolic problem $u_t = u_x$. The three types considered are the high-order centered differences of Kreiss and Oliger, the extra-high-order spline–Galerkin schemes discovered by Thomée, and the quite-high-order implicit centered difference schemes of Kreiss. Trapezoidal, leap-frog (midpoint rule), and 4th-order Padé time discretizations are introduced. The work necessary to solve each full discretization is minimized, for given error requirements, by balancing the number of intervals per wavelength against the number of intervals per time period. The resulting data are used to compare the efficiency of these finite-element and finite-difference methods. The efficacy of smooth spline interpolation of the approximations arising from the difference schemes is also discussed. (auth)

20578 (LBL-2033) NUMERICAL STUDY OF THE DISCRETE MINIMAL SURFACE EQUATION IN A NONCONVEX DOMAIN. Concus, P. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1973. Contract W-7405-eng-48. 15p. Dep. NTIS $4.00.

A discrete approximation to the minimal surface equation is solved numerically on an L-shaped domain with Dirichlet boundary conditions. The nature of the solution discontinuity at the vertex of the reentrant corner is depicted graphically. (9 figures) (auth)

20579 (NVO-412-2) GET: GRAPHICS EDITING OF TEXT. Users' Manual. Lakeotes, C. D. (Computer Science Corp., Las Vegas, Nev. (USA)). May 1973. Contract AT(26-1)-412. 51p. Dep. NTIS $5.45.

The GET system was provided to satisfy the need for modifying any data file formatted in an acceptable manner. Specifically, all initial data is contained in 80-character punch cards, magnetic tape, or disk. The modifications are made in an interactive environment utilizing the CDC 252-2 Display Console. The primary feature used to facilitate the interactive process is displaying the file in a page format. (auth)

20580 (NVO-412-3) GET: GRAPHICS EDITING OF TEXT. Program Manual. Lakeotes, C. D. (Computer Science Corp., Las Vegas, Nev. (USA)). May 1973. Contract AT(26-1)-412. 71p. Dep. NTIS $5.45.

The GET program allows the user the ability to modify any card image data file in an interactive environment using the CDC 252-2 Display Console. A primary feature used to facilitate the interactive process is displaying the file to the user in a page by page format on the scope. The program has many positioning options for page, line and character pointers and cursors. (auth)

20581 (NVO-412-4) GRAND: GRAPHICS ANALYSIS OF NUMERIC DATA. Program Manual. Lakeotes, C. D. (Computer Sciences Corp., Las Vegas, Nev. (USA)). May 1973. Contract AT(26-1)-412. 150p. Dep. NTIS $5.45.

Program GRAND (Graphics Analysis of Numeric Data) is an interactive graphics program which provides the user the capability to select, display, modify, and analyze his X–Y data in an interactive environment. The use of this interactive program allows the user to iterate among the major capabilities of the program until the desired result is achieved. The types of analyses which may be performed using GRAND include the fitting of X–Y data with up to a tenth order least-squares polynomial and the interpolation of X–Y data with a sliding nth order Lagrangian polynomial. In general, GRAND gives the user a powerful tool in the form of an interactive program with which to: (1) select any X–Y data set; (2) display the data in a meaningful manner to the user; (3) modify the data using wild point editing, interval editing, constant shifts, etc; and (4) analyze the data via a least-squares type curve fit. (auth)

20582 (NVO-412-5) GRAND: GRAPHICS ANALYSIS OF NUMERIC DATA. Users' Guide. Lakeotes, C. D. (Computer Sciences Corp., Las Vegas, Nev. (USA)). May 1973. Contract AT(26-1)-412. 64p. Dep. NTIS $5.45.

20583 (ORNL-TM-4275) DYNOR: DYNAMIC ANALYSIS OF STRUCTURAL SYSTEMS. Holmes, R. M. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 89p. Dep. NTIS $6.50.

DYNOR is a computer program that was developed to analyze the response of structural systems to the vibratory ground motion of earthquakes as well as sinusoidal motion. This program can be applied to structural systems that can be mathematically idealized with beam-type elements which have no more than three degrees of freedom per joint. The input for the earthquake vibratory motion may be either time-history or response-spectrum data. The program is written in FORTRAN IV language, and it is operable on the IBM 360/91 computer at Oak Ridge National Laboratory. The supporting theory and procedures are described and detailed instructions for the use of DYNOR are presented herein. (auth)

20584 (SGAE-2130) COMPUTER PROGRAMS FOR EVALUATING CAVE MEASUREMENTS. Buschbeck, F.; Pethers, G. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). May 1973. 14p. (In German). Dep. NTIS (U. S. Sales Only) $3.00.

20585 (SLA-73-627) COMPUTER PROGRAMS FOR CALCULATING CERTAIN FACTORS ASSOCIATED WITH NORMAL RANDOM VARIABLES. Amos, D. E.; Daniel, S. L. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 35p. Dep. NTIS $3.75.

This report documents three computer programs, ONESID, TWOSID, and GETKSTR, which evaluate cumulative probabilities for the solution of percent point equations associated with products and quotients of independent normal variates. (auth)

20586 (SLA-73-628) DEVELOPMENT AND COMPARISON OF SEVERAL ANALYTICAL MODELS FOR THE PLANAR TURBULENT NEAR WAKE IN SUPERSONIC FLOW COMBINING COMPONENT AND CRITICAL POINT METHODS. Smith, J. H. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 146p. Dep. NTIS $3.00.

The supersonic ($1.5 \leq M_\infty \leq 5$) turbulent base flow problem is solved in a novel and expedient manner with integral techniques. The resulting computer code, NRWAKE, performs a complete base flow analysis in 5 to 10 seconds on the CDC 6600. Thus it should be quite useful in an industrial context for parametric preliminary design studies to identify final design candidates worthy of more detailed analysis. All desired flow parameters are obtained with accuracy consistent with the usual knowledge of input data. The heretofore separate branches of effort stemming from the Chapman–Korst component analysis and the Crocco–Lees critical point method are merged. The dichotomy is ended by using the Chapman–Korst component analysis to establish all flow parameters in terms of assumed values of base pressure. A final closure is then obtained by using two interpretations of the Crocco–Lees critical point theory to select the correct base pressure along with corresponding parameters of interest. Thus, the determination of correct base pressure is based on strong interaction concepts which link the inner viscous solution to the outer inviscid flow. (5 tables, 35 figures, 79 references) (MOW)

20587 (SLA-73-5529) COMMAND GRAPHS. Simmons, G. J. (Sandia Labs., Albuquerque, N. Mex.). 1972. 47p. (CONF-730636-1). Dep. NTIS $4.50.

From international conference on combinatorics; Keszthely, Hungary (23 Jun 1973).

A command graph G(k,l,n) is defined to be an undirected graph without loops on n + 1 vertices, one of which is designated as the source (command post) and the other n as outputs (outposts), in which cutting k edges isolates at most l of the outputs from the source. Parallel edges are permitted. This paper is concerned with characterizing minimal command graphs, i.e., those

command graphs having the least possible number, L(k,l,n), of edges. (auth)

20588 (SLL-73-250) USER'S MANUAL FOR CSPLINE (CUBIC SPLINE). Quock, H. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. Contract AT(20-1)-789. 26p. Dep. NTIS $3.50.

CSPLINE (Cubic SPLINE) is a curve-fitting routine that will approximate and smooth a given ordered set of points. The resulting curve is made up of a series of cubic polynomials. This document serves as a user's guide to prepare input data to CSPLINE. This routine was developed primarily to fit a curve or an APT (Automatic Programmed Tool) tabulated cylinder through a given ordered set of points. (auth)

20589 (SLL-73-262) CDC 6600 FOR THE BESSEL FUNCTIONS $J_0(Z)$ AND $J_1(Z)$ FOR ARBITRARY VALUES OF THE COMPLEX VARIABLE Z. Amos, D. E.; Huddleston, R. E. (Sandia Labs., Albuquerque, N. Mex.; Sandia Labs., Livermore, Calif.). Jul 1973. Contract AT(29-1-789. 24p. Dep. NTIS $3.25.

This report documents the subroutine BESC which computes the $J_0(Z)$ and $J_1(Z)$ Bessel functions of the first kind for arbitrary values of the complex variable, Z. (auth)

20590 (TID-26365) RLES CYLINDRICAL BEARING PROGRAMS. Tomlin, R. L.; Rose, J. S. (Virginia Univ., Charlottesville. School of Engineering and Applied Science). Sep 1964. Contract AT(40-1)-1779. 40p. (EP-3912-523-64-U). Dep. NTIS $4.00.

Two computer programs are described that deal with cylindrical, fluid-film bearings. The first program computes pressure distributions in bearings and the forces that result from integrating over the pressure field. The second program is an auxiliary routine used to plot pressure cross sections. (auth)

20591 (TID-26367) DMAIN, A GENERALIZED DISK UTILITY PROGRAM. Concaildi, G. A.; George, R. D. (Argonne National Lab., Ill.). 23 Mar 1973. 6p. Dep. NTIS $3.00.

A generalized disk utility program written in Fortran for the CDC-924A computer is now available. The program is called DMAIN. Its primary purpose is to make manipulation of disk data sets simple. However, limited tape manipulation is available. A description of the vocabulary needed to execute DMAIN is presented. (auth)

20592 (UCID-30050(Pt.4)) CONSTRUCTION OF MATHEMATICAL SOFTWARE. Part VI. Nonlinear Least Squares Codes. Johnston, B. (California Univ., Livermore. Lawrence Livermore Lab.). Jan 1973. Contract W-7405-eng-48. 81p. Dep. NTIS $6.25.

The following chapters are included: (1) elementary statistics, (2) the least-squares problem, (3) the univariate algorithm, (4) the gradient search algorithm, (5) Gauss's method, and (6) the Levenberg-Marquardt algorithms. (MOW)

20593 (UCRL-51397) CODE FOR VIEWING MAFCO CONDUCTORS FROM ANY ANGLE. Haratani, T. N.; Moir, R. W. (California Univ., Livermore. Lawrence Livermore Lab.). 15 Jun 1973. Contract W-7405-eng-48. 14p. Dep. NTIS (U. S. Sales Only) $4.00.

A code designated MPVER rotates MAFCO conductors so that they can be viewed from any angle. The code makes it easier to visualize conductors and serves as a check for MAFCO input. The equations describing the rotating process are given. (auth)

20594 (UCRL-51407) RESEARCH ON PIPELINE PROCESSORS: REVIEW OF LITERATURE ON SCHEDULING. West, D. G. (California Univ., Livermore. Lawrence Livermore Lab.). 14 Jun 1973. Contract W-7405-eng-48. 13p. Dep. NTIS $4.00.

The designing of pipeline processors includes problems in the scheduling of segments of various procedures for different hardware units (pipes) in the computer. This paper is a review of the literature on scheduling published primarily by business, industrial engineering, and operations research sources. (LMT)

20595 WIENER INTEGRAL AND ITS NUMERICAL ESTIMATION. Chapa Vergara, S. V. Mexico City; Instituto Politecnico Nacional (1973). 177p. (In Spanish).

Thesis.

The preliminaries for the construction of the Wiener integral are outlined. The cylindrical conjunct is defined, and the construction of the elementary integral on the finite real function conjunct is shown. Procedures for the evaluation of the function F[x] are given. The Monte Carlo methods for the spatial integration of functions are examined. Two forms which can be used to calculate numerically the Wiener integral are given. Results obtained with this method of numerical evaluation are given. (JSR)

Miscellaneous

20596 (AEC-tr-7449) EXPERIENCES WITH ACTIVATED HYDRAZINE FOR CHEMICAL DEGASSING. Kallfass, H. Translation of pp 2-5 from the VGB Feedwater Conference, Essen, Germany, 1970. 10p. Dep. NTIS $3.00.

20597 (AEC-tr-7453) PROCESS OF REACTION DIFFUSION OF SILICON INTO NIOBIUM. Sirota, N. N.; Sokolov, S. N. Translated from Dokl. Akad. Nauk BSSR; 15: 15-17(1971). 8p. Dep. NTIS $3.00.

The process of reaction diffusion of Si into Nb at isothermal annealing temperatures from 800 to 1100°C was studied. Diffusion coefficients, preexponential factors, and activation energy for reaction diffusion of Si into Nb in the given range of temperatures were calculated. The Russian original was previously abstracted as NSA 25: 27239. (DLC)

20598 (ANL/ESP-1) FISH PROTECTION AT WATER DIVERSIONS AND INTAKES: A BIBLIOGRAPHY OF PUBLISHED AND UNPUBLISHED REFERENCES. Sharma, R. K. (comp.) (Argonne National Lab., Ill.). May 1973. Contract W-31-109-eng-38. 36p. Dep. NTIS $4.00.

An attempt is made to include references to all of the information pertaining specifically to fish protection at power plant intakes. However, literature in such related areas as swimming speed of fishes is not covered, nor is the bibliography complete with respect to the use of electricity for fish guidance. In particular, the foreign literature was not searched on this topic. Also, the use of chemorepellents needs further investigations before it can even be considered as a means of diverting fishes at power plant intakes. (204 references) (LMT)

20599 (BDX-613-797) MATERIAL AND PROCESS DEVELOPMENT OF POLYURETHANE FOAM, FY73-1. Quarterly Report. Fender, J. R. (Bendix Corp., Kansas City, MO). Apr 1973. Contract AT(29-1)-613. 32p. Dep. NTIS $3.75.

This report summarizes a continuing evaluation of AVCO's ICU-36 isocyanurate material, a static compressive study in which foam and metal or wood composites are tested, early phases of a dynamic testing program, and a study of flame retardant additives. A final summarization of a past study of the effect of cure temperature on foam strength and shrinkage properties is also presented. (auth)

20600 (BDX-613-866(Rev.)). CHEMICAL VAPOR DEPOSITION OF ALUMINUM. Final Report. Clay, F. A. (Bendix Corp., Kansas City, MO). Aug 1973. Contract AT(29-1)-613. 14p. Dep. NTIS $3.00.

Chemical vapor deposition of aluminum was studied as an alternate process to electrodeposition. Using triisobutyl aluminum as the metal source, aluminum was deposited from both vapor and liquid onto both metallic and nonmetallic substrates. The visual appearance of the deposits obtained was good. Additional development of the process equipment would be required before these techniques could be used in production. (auth)

20601 (BDX-613-885) ECONOMIC IMPROVEMENT OF INVENTORY SAMPLING. Rinker, C. D. (Bendix Corp., Kansas City, MO). Apr 1973. Contract AT(29-1)-613. 12p. Dep. NTIS $3.00.

Improved methods of inventory sampling to determine record accuracy are discussed. Application is made to Central Stores and Test Equipment Stores inventories at Bendix, Kansas City. An improved sampling procedure is outlined that improves efficiency by 24%. Similar economic savings are possible for any stratified inventory in which the statistical variance among the strata differ significantly. (auth)

20602 (BDX-613-930(Rev.)) EFFECTS OF MOISTURE UPON SPIRAL FLOW IN THERMOSET MOLDING COMPOUNDS. Conway, J. M. (Bendix Corp., Kansas City, MO). Aug 1973. Contract AT(29-1)-613. 23p. Dep. NTIS $3.25.

The effects of moisture on spiral flow in precured thermoset molding compounds were evaluated. Two mineral-filled compounds were investigated: a cellulose-filled phenolic and a long-glass-fiber-reinforced diallyl phthalate. Results indicate that the flow properties, and therefore the molding properties and characteristics of these compounds are extremely sensitive to moisture in the uncured state. (auth)

20603 (BDX-613-948) EXTRUDE HONE DEBURRING. Gillespie, L. K.; Luebbert, L. H. Jr. (Bendix Corp., Kansas City, MO). Aug 1973. Contract AT(29-1)-613. 29p. Dep. NTIS $3.50.

The success of miniature timers, switches, or actuators depends on burr-free sharp-edged parts. Traditional methods of making these nearly perfect edges on miniature parts are costly

and often cannot produce the precision or repeatability specified on some of these piecepart designs. Extrude hone deburring can produce burr-free edges with a 0.002 inch (50.8 μm) maximum edge break. Preliminary test results show that the extrude hone deburring process can decrease deburring times by 50 percent or more on many parts. (auth)

20604 (BNL-17948) ADSORBED HELIUM FILM: TWO DIMENSIONALITY VERSUS REALITY. Novaco, A. D. (Brookhaven National Lab., Upton, N. Y.). 1973. 10p. (CONF-730635-1). Dep. NTIS $3.00.

From symposium on monolayer and submonolayer helium films; Hoboken, New Jersey, USA (7 Jun 1973).

20605 (BNL-18006) EVOLUTIONARY AND DEVELOPMENTAL CONSIDERATIONS OF THE VARIABILITY OF NUCLEAR PARAMETERS IN HIGHER PLANTS. I. Genome Volume, Interphase Chromosome Volume, and Estimated DNA Content of 236 Gymnosperms. Price, H. J.; Sparrow, A. H.; Nauman, A. F. (Brookhaven National Lab., Upton, N. Y.). 1973. 40p. (CONF-730643-2). Dep. NTIS $4.00.

From symposium on basic mechanisms in plant morphogenesis; Upton, New York, USA (4 Jun 1973).

20606 (BNWL-SA-4579) APPLICATION OF THE EDDY CURRENT METHOD TO HIGH-SPEED THICKNESS MEASUREMENT. Crowe, J. C.; Libby, H. L.; Skorpik, J. R. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. 14p. (CONF-730451-1). Dep. NTIS $3.00.

The high-speed production of small-caliber ammunition cartridges presents many new problems for quality assurance instrumentation. An example is the requirement of measuring the wall-thickness profile of 5.56-mm brass cartridges cases at production line speeds of up to 1600 cartridges per minute. An eddy current system is presently being developed at Battelle-Northwest to perform this inspection. The inspection system will determine the cartridge case wall thickness profile at four positions along the case with nominal thickness ranging from 0.0165 in. to 0.0075 in. (LMT)

20607 (CEA-R-4396) STUDY AND REALIZATION OF ULTRA-RAPID LOGIC CIRCUITS IN MIDDLE-SCALE INTEGRATION. Verhaeghe, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1973. 146p. (In French). Dep. NTIS (U. S. Sales Only) $9.50.

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble (France).

Middle scale integration is associated with subnanosecond logic in order to realize ultra-rapid logic circuits, characterized by a 40-gate complexity for a dissipation lower than 1 watt. For this purpose, one must find a high special and low power gates family. With use of current mode logic, and sharing of the logic circuit between an internal part and interfaces, mean dissipation can be lowered to 20 mW while mean propagation time is 1 ns by gate. So, circuits present a speed-power product of 20 mW × ns, giving to them one of the best places among the other types of ultrarapid logic. Another interesting aspect of the work is the use of diffused components master slice ineluding specialized integrated cells, fitting well complex circuits. With this master slice and the different gates, settlement of mean complexity circuits family is foreseen. The elements of this family would be able to reply to the main needs of rapid electronics. (auth)

20608 (CEA-R-4429) EXPERIMENTAL STUDY OF RAYLEIGH SCATTERING WITH A RUBY LASER BEAM: RELATIVE VARIATION OF SCATTERED LIGHT WITH THE NUMBER OF SCATTERING CENTERS AND NATURE OF THE GASES. Bayer, C. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Jun 1973. 67p. (In French). Dep. NTIS (U. S. Sales Only) $5.50.

The experimental variation of the scattered light with the number of scattering centers and with the refractive index of gases is in agreement with the theoretical Rayleigh scattering. A direct calibration system gives the absolute value of the Rayleigh ratio. The experimental value appears to be half of the theoretical one. (auth)

20609 (CONF-730715-1) CATION SELF-DIFFUSION IN RUTILE. Lundy, T. S.; Coghlan, W. A. (Oak Ridge National Lab., Tenn.). 1972. 16p. Dep. NTIS $3.00.

From conference on lattice defects in ionic crystals; Marseille, France (2 Jul 1973).

Diffusion in rutile (TiO_2) is characterized by extreme anisotropy with very large diffusion rates along the c-direction in the body-centered tetragonal structure for interstitial elements such as lithium and boron. In marked contrast, substitutional elements appear to diffuse in the a- and c-directions at similar rates. Cation self-diffusion was examined in TiO_2 both theoretically and experimentally, and it was found that the relative diffusion coefficients in the two directions can be used along with their partial correlation functions to identify the jumps taking place in the bct cation sublattice. (MCW)

20610 (CONF-730817-2) RADIOISOTOPE TECHNIQUES IN DELINEATION OF THE ENVIRONMENTAL BEHAVIOR OF CADMIUM. Van Hook, R. I. Jr.; Blaylock, B. G.; Bondietti, E. A.; Francis, C. W.; Huckabee, J. W.; Reichle, D. E.; Sweeton, F. H.; Witherspoon, J. P. (Oak Ridge National Lab., Tenn.). 1973. 28p. (SM-175/22). Dep. NTIS $3.50.

From symposium on nuclear techniques in comparative studies of food and environmental contamination; Otaniemi, Finland (27 Aug 1973).

Information obtained in these radiotracer studies is providing insight into the behavior of cadmium in aquatic and terrestrial ecosystems, especially transport rates of cadmium and potential biomagnification or dilution in food chains. The factors that influence the incorporation of cadmium into vegetative material, as well as those affecting residence time in ecosystems, have been identified. Use of ^{109}Cd also has permitted evaluation of a cadmium specific electrode as a tool for rapid assay of free cadmium ions in soil solutions. (7 tables, 6 figures, 28 references). (LMT)

20611 (COO-1332-88) RAPTOR REHABILITATION AND CONSERVATION IN MINNESOTA. Fuller, M. R.; Redig, P. T.; Duke, G. E. (Minnesota Univ., St. Paul). 1973. 17p. (CONF-730340-2). Dep. NTIS $3.00.

From conference on raptor conservation techniques; Ft. Collins, Colorado, USA (22 Mar 1973).

20612 (COO-2115-4) STATISTICAL STUDY OF BASIC ECOLOGICAL VARIATIONS IN A SHORTGRASS PRAIRIE SITE. Final Report, September 14, 1972–June 30, 1973. Bonham, C. D. (Colorado State Univ., Fort Collins). 1973. Contract AT(11-1)-2115. 85p. Dep. NTIS $6.25.

An outstanding characteristic of vegetation is its spatial variability. Much of the work of classical ecology has involved description of patterns of vegetation in an effort to better understand spatial variability. In this study, emphasis was on statistical description of spatial variability. The primary statistical techniques employed were: (1) experimental design models, (2) directional analysis of variance, (3) principal components analysis, and (4) hierarchical similarity analysis. A synopsis of the results obtained using each of the techniques follows. (17 tables, 10 figures, 14 references) (LMT)

20613 (COO-2204-2) ACOUSTIC EMISSION AND DISCONTINUOUS YIELDING. Hartman, W. F. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Mechanics and Materials Science). 1971. 27p. (CONF-730810-2). Dep. NTIS $3.50.

The replicable features of the discontinuous yielding of dead-weight loaded annealed specimens of aluminum and brass are documented and compared with the acoustic emission accompanying such deformations. It is shown that one method of acoustic-emission monitoring provides data that are consistent with the hypothesis that the elastic energy released during a yield increment is proportional to the elastic energy stored since the last yield increment. Another method of monitoring gives a better indication of the number of acoustical events occurring and permits assessment of the frequencies of the emissions. It is concluded that a major portion of the acoustic emission during the strain-loading of crystalline materials is primarily associated with elastic-energy release during the propagation of nonhomogeneous deformation, which is the genesis of the Portevin–Le Chatelier effect during dead-weight loading. (auth)

20614 (COO-3279-6) ECOLOGY OF THE PLANKTON OF THE CHESAPEAKE BAY ESTUARY. Progress Report, September 1, 1972–June 30, 1973. Taylor, W. R. (Johns Hopkins Univ., Baltimore, MD). 1973. Contract AT(11-1)-3279. 128p. Dep. NTIS $8.50.

20615 (EDFB-IBP-73-6) TERRESTRIAL PRIMARY PRODUCTION. Proceedings of Interbiome Workshop on Gaseous Exchange Methodology, Oak Ridge National Laboratory, April 13–14, 1972. Dinger, B. E.; Harris, W. F. (eds.) (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 184p. (CONF-720478-). Dep. NTIS $7.60.

From interbiome workshop on gaseous exchange methodology conference; Oak Ridge, Tennessee, USA (13 Apr 1972).

20616 (INP-817) APPLICATION POSSIBILITIES OF RADIOACTIVE TRACERS IN THE PARAMETERS IDENTIFICATION OF PARTICULAR OBJECTS OF A COPPER ORE PREPARATION PLANT. Korbel, K.; Michalik, A.; Nizegorodcew, P.; Plechta, J. (Institute of Nuclear Physics, Krakow (Poland)). 1972. 62p. (In Polish). Dep. NTIS (U. S. Sales Only) $5.25.

On the basis of the general principles of the radiotracer technique, the possibilities and advantages of its application in identi-

fication measurements in copper ore-dressing plants are presented. The results of the spectrometric analysis of radiation excited in the copper ore by reactor activation are given. This kind of activation is applicable for the labelling of copper ores. The principles and methods of interpretation of the measurement results are presented, particular attention being paid to mathematical models. (tr-auth)

20617 (INP-827) ELECTRIC FIELD GRADIENTS IN CHARGE-DEFECTED LATTICES. Pustowka, A. J.; Sawicka, B. D.; Sawicki, J. A. (Institute of Nuclear Physics, Krakow (Poland)). Mar 1973. 22p. Dep. NTIS (U.S. Sales Only) $3.25.

Computer experiments were performed to find the electric field gradients at nuclei in randomly charge-defected cubic and hexagonal lattices. Possible modifications of Moessbauer spectra and TDPAC attenuation factors are discussed. (auth)

20618 (INP-828) MOESSBAUER STUDY OF ^{57}Fe IMPLANTED IN SILICON. Sawicki, J. A.; Sawicka, B. D.; Lazarski, S.; Maydell-Ondrusz, E. (Institute of Nuclear Physics, Krakow (Poland)). Feb 1973. 11p. Dep. NTIS (U.S. Sales Only) $3.00.

Moessbauer absorbers were produced by implantation of 35-keV ^{57}Fe ions in Si single crystals with a magnetic isotope separator. The Moessbauer spectra of the samples are discussed. (auth)

20619 (K-Trans-66) STUDIES OF SECONDARY FLOW IN AXIAL COMPRESSOR CASCADES. Bitterlich, W.; Kuemmel, W. Translated from Z. Flugwiss.; 20: No. 1-2, 52-59(1972). 17p. Dep. NTIS $3.00.

The principal types of secondary flows occurring in axial-flow compressors are discussed and the possibilities of measuring such flows are presented. The measuring of a plane behind a cascade was found to be a satisfactory and practicable procedure. With regard to the various causes of the secondary flows, the primary parameters of influence for their occurrence can be indicated and relations suggested which are intended to make their future calculation possible. As a magnitude of reference for the intensity of secondary flows, the kinetic energy of the secondary flows and the losses produced by secondary flows are proposed. The losses occurring in a compressor are exactly defined and the losses caused by secondary flows distinguished from the other losses involved. A few numerical results for a point of operation of a single-stage axial-flow compressor are dealt with. (auth)

20620 (KFKI-73-11) POOL BOILING HEAT TRANSFER. Maroti, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Mar 1973. 27p. Dep. NTIS (U.S. Sales Only) $3.50.

The predominant part of the high heat transfer rate in nucleate boiling is associated with the bubbles departing from the heating surface. As the heat required for the growth of bubbles originates from the surrounding superheated liquid, it was supposed that the total amount of heat transported by the bubbles may be expressed as the excess enthalpy of the liquid layer around them. For determining the heat flux it was also necessary to find an adequate expression for the cavity size distribution and for the frequency of bubble generation. The resulting heat flux–wall superheat relationship can correlate experimental results up to a relative pressure of 0.9. (auth)

20621 (LA-5151-MS(SUPPL. 1)) CO_2 GAS LASER STUDIES. Mills, C. B. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 16p. Dep. NTIS $4.00.

Electron excitation of molecular levels determines vibrational energy storage, which may be used for amplification of a laser beam. Studies by Frost and Phelps, and others, have shown that excitation cross sections may be derived from integral studies of electron mobility and diffusion constants. It was shown by laser-beam amplification studies that these cross sections must be at least approximately correct. This was done by integration of energy conservation equations in which excitation rates and inter-level vibrational energy exchange rates were component terms, and resulting vibrational energy-level populations are components of the laser gain equations. Excitation rates were determined by integration of the Boltzmann equation for electron energy distribution. The excitation cross sections were taken from Phelps' work, and the potential gradient per molecule was determined by solution of the current continuity equation using transport constants derived by methods described by Phelps. The laser gain equations were then used for optimization studies of laser energy storage parameters, which showed that the quantity of energy stored, about 10% of electrical energy supplied, is not a strong function of any single parameter except time. Results are given for $He/N_2/CO_2$ mixtures. (auth)

20622 (LA-tr-73-31) SHOCK WAVE DIFFRACTION AT SHARP CORNERS. Schultz, S. Translated from Z. Flugwiss.; 20: 179-187(1972). 29p. Dep. NTIS $3.50.

The shape of a diffracted wave is computed semi-empirically. For a diffracting angle of a corner of $\phi_\omega = -180°$, the dependency on the shock, Mach number M_0 of the undisturbed shock wave is determined theoretically, whereas the dependence on the variable angle ϕ is determined by a few experiments. This result is enlarged for any diffracting angle ϕ_ω by considering the propagation of a perturbation (effected by a change of the diffracting angle, for example) along the diffracted shock front. The agreement between the result of these considerations and experiments proved to be very satisfactory. (auth)

20623 (LBL-1476) EVALUATION OF THE END-QUENCH TEST AS A DESIGN CRITERION. Lott, R. N. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1973. Contract W-7405-eng-48. 43p. Dep. NTIS $4.25.

Thesis.

End-quench test results have commonly been used to design quenching conditions in the hope that the desired microstructure will be obtained in the quenched piece. Investigation of this practice shows it to be invalid in principle. The correlation of end-quench data to other quenching conditions is based either on equivalent measured final hardness values or, more generally, on equivalent cooling rates at 1300°F during quenching. The correlation based on equivalent hardness values is invalid because hardness is not a sensitive indication of microstructure or properties of a quenched steel. Correlations based on equivalent cooling rates are not valid because the final properties are shown not to be dependent on the cooling rate at 1300°F during the quench. This is because the final microstructure of a quenched piece depends on the path of the cooling curve through the continuous cooling transformation diagram. The shape of the cooling curve is a function of the quenching conditions and, therefore, its path is not determined by the cooling rate at 1300°F. (auth)

20624 (LBL-1484) AN IRON–NICKEL–TITANIUM ALLOY WITH OUTSTANDING TOUGHNESS AT CRYOGENIC TEMPERATURE. Jin, S.; Morris, J. W. Jr.; Zackay, V. F. (California Univ., Berkeley. Lawrence Berkeley Lab.). Mar 1973. Contract W-7405-eng-48. 20p. (CONF-730805-3). Dep. NTIS $3.00.

Research has shown that the alloy Fe–12Ni–0.25Ti may be processed to have an outstanding combination of strength and toughness at cryogenic temperatures. Some of the results obtained to date with this alloy are presented and compared with the properties of two commonly used cryogenic steels. Tensile properties, impact properties, and preliminary results of fracture toughness tests are presented. (auth)

20625 (LBL-1491) STRUCTURE AND PROPERTIES OF TRIP STEELS PROCESSED BY DEFORMATION AND THERMAL CYCLING. Adkins, H. E. Jr. (California Univ., Berkeley. Lawrence Berkeley Lab.). Apr 1973. Contract W-7405-eng-48. 52p. Dep. NTIS $4.75.

Thesis.

Strengthening of metastable austenitic chromium-containing TRIP (transformation induced plasticity) steels by thermal and thermomechanical processing was investigated. Three processing treatments were studied for their influence on structure and mechanical properties. A considerable increase in strength resulted from the use of small amounts of deformation by rolling at temperatures near the M_s temperature to form "stress-induced" martensite. On heating to an elevated temperature, martensite reverted to austenite by a diffusionless reaction. The reversion was accompanied by diffusion-based reactions resulting in the formation of austenite of a lower stability. After repeated cycles of the processing treatments, a fine and uniform structure resulted. Room-temperature yield strengths of steels with the fine structure were much higher than that of annealed austenite, but were lower than those of TRIP steels produced by 80% warm work. Selected specimens exhibited higher yield strengths in 100°C tests suggesting that the low room-temperature yield strengths were due to the stress-induced formation of martensite. (3 tables, 16 figures, 20 references) (auth)

20626 (LBL-1802) SOME CURRENT AND FUTURE TRENDS OF HIGH-VOLTAGE TRANSMISSION ELECTRON MICROSCOPY. Thomas, G. (California Univ., Berkeley. Lawrence Berkeley Lab.). Mar 1973. Contract W-7405-eng-48. 6p. (CONF-730816-1). Dep. NTIS $3.00.

From EMSA meeting; New Orleans, Louisiana, USA (14 Aug 1973).

It is shown that 1 MeV is an upper limit for most applications in materials science. Factors limiting electron microscopy of organic materials are discussed; 3 MeV may result in some improvement. Images are given for defects in Si. Antiphase domain boundary observations in lunar anorthite are reported; comparison with calculations show that the vectors are of type $\frac{1}{2}$[110] for b domains and $\frac{1}{2}$[111] for c domains. (DLC)

20627 (LBL-1831) MASS TRANSFER COEFFICIENT IN PACKED BEDS AT LOW REYNOLDS NUMBERS. Yip, H. H. K. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1973. Contract W-7405-eng-48. 55p. Dep. NTIS $4.75.

Thesis.

Liquid-phase mass transfer rates for a packed bed in the Reynolds numbers range of 0.01 to 0.1 were obtained by taking advantage of the packed bed characteristics of a porous flow-through electrode. The model reaction chosen for the study was the reduction of ferricyanide at a porous flow-through electrode made of packed SS 440C spheres. The flow solution was made up of a ferri-ferrocyanide redox system with potassium nitrate as excess supporting electrolyte. (LMT)

20628 (LBL-1832) VAPORIZATION STUDIES OF STRONTIUM SULFATE. Fuke, L. M. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1973. Contract W-7405-eng-48. 26p. Dep. NTIS $3.50.

Thesis.

The equilibrium dissociation pressure of strontium sulfate was measured, for the first time, by the torsion–effusion method in the temperature range 1370 to 1540°K. The total pressure for the reaction $SrSO_4(s) = SrO(s) + SO_2(g) + \frac{1}{2} O_2(g)$ can be represented as $\log P = -(1.405 \pm 0.009) \times 10^4/T + (7.167 \pm 0.065)$, where the indicated errors are standard deviations from least-squares analysis. The Second Law Method yielded for the enthalpy of vaporization (ΔH^0_v) 127.4 kcal/gm-atom and for the entropy of vaporization (ΔS^0_v) 58.5 e.u. No dependency of vapor pressure upon the orifice area was observed. (auth)

20629 (LBL-1834) EXPERIMENTAL TECHNIQUES FOR GROWING UNIDIRECTIONALLY SOLIDIFIED ORIENTED EUTECTICS. Salmon, L. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1973. Contract W-7405-eng-48. 78p. Dep. NTIS $6.00.

Thesis.

Relevant factors for growing aligned eutectics and the experimental techniques are discussed. A review of the methods used for evaluation of the resulting microstructures is given. (71 references) (auth)

20630 (LF-tr-57) INVESTIGATIONS OF PHYSIO-PATHOLOGY OF RESPIRATION. IV. Prolongation of the Dead Space as a Practical Means of Obtaining Hyperventilation. Duomarco, J.; Diaz-Romero, C. Translated by A. Valdivia (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. from Arch. Urug. Med., Cir. Espec.; 10: 599-606(1937). 5p. Dep. NTIS $3.00.

20631 (NRC-TT-1626) STRUCTURE AND DEVELOPMENT OF THE INTEGUMENT OF SIRENIA. Dosch, F. Translated by D. A. Sinclair (National Research Council of Canada, Ottawa) from Jena. Z. Med. Naturwiss.; 53: 805-854(1914). 56p. Dep. NTIS (U. S. Sales Only) $5.00.

20632 (ORNL-TM-4209) APPLICATION OF MODERN SOLVENT EXTRACTION TECHNIQUES TO THE REMOVAL OF TRACE QUANTITIES OF TOXIC SUBSTANCES FROM INDUSTRIAL EFFLUENTS. Groenier, W. S. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 20p. Dep. NTIS $3.00.

A proposal to fabricate a continuous 4-stage laboratory-scale mixer-settler has resulted from an examination of the engineering aspects of applying solvent extraction techniques to the treatment of industrial effluents. Internal recycle of one liquid phase is featured in each stage to maintain a certain phase ratio, and thereby minimize entrainment losses at the extreme flow ratios that are necessary in this application. The proposed system is to be used to study flowsheet feasibility, to develop operating criteria, and eventually to demonstrate the removal of trace quantities of toxic substances from actual industrial effluents. The system is designed for general application to a wide variety of liquid–liquid extractions but would initially be used to study the removal of mercury from brine solutions by extraction with high-molecular-weight amines. (auth)

20633 (ORNL-tr-2638) X-RAY STUDIES ON THE AGE HARDENING OF AN ALUMINUM–COPPER ALLOY BY MEANS OF SMALL-ANGLE ROTATING PHOTOGRAPHS. Gerold, V. Translated by R. G. Mansfield from Z. Metallk.; 45: No. 10, 593-599(1954). 22p. Dep. NTIS $3.25.

X-ray studies on an age-hardenable 5% aluminum–copper alloy show that there are two different kinds of bands that may be attributed to cold-hardening zones and heat-hardening zones. The cold-hardening zones completely disappear on heating for a short time at around 200°(regression), while the heat-hardening zones develop only with increasing heating time along with precipitation. The θ'' phase (a kind of overstructure in the mixed crystal) is not a continuous further development of the cold-hardening zones; it is directly connected with heat hardening. (25 references) (auth)

20634 (ORNL-tr-2710) EFFECT OF THE HYDROSTATIC PRESSURE OF THE MEDIUM ON THE LONG-TERM STRENGTH OF STEEL. Voznyi, T. D.; Popovich, V. V. Translated by Martha Gerrard (Oak Ridge National Lab., TN) from Fiz.-Khim. Mekh. Mater.; 8: No. 5, 62-64(1972). 5p. Dep. NTIS $3.00.

The effect of an increase to 100 atm of the pressure of bismuth, hydrogen, and lithium on the long-term strength of Kh18N10T steel, under strain of a complementary axial force at a temperature of 700°C was studied. To evaluate the effect of increased hydrostatic pressure of the medium, samples were also tested for long-term strength with uniaxial tension in an argon atmosphere (the inner cavities of the samples were not hermetically sealed) and in molten bismuth. To clarify the degree of the effect of transmitted pressure of the gas medium, experiments were made with increased hydrogen and argon pressures (no bismuth). It is concluded that an increase in the hydrostatic pressure of a liquid-metal medium can cause a further decrease in the long-term strength of a construction material. Tests at higher melt pressures are more rigid, and a decrease in long-term strength may be observed even when no effect of the medium is observed at normal pressure. (MCW)

20635 (ORO-3087-51) CONDUCTIVITY TENSORS IN METALS AND SEMICONDUCTORS. Final Report. Reynolds, J. M. (Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy). 1972. Contract AT(40-1)-3087. 14p. Dep. NTIS $3.00.

Work completed under the contract is listed by the year for each of nine years of the contract. The particular transport effects studied during the contract period are listed by the effect and by the material. The Fermi surface studies are given by the technique. The Knight shift measurements are mentioned. The graduate students, publications, and papers presented at meetings are listed. (MHR)

20636 (RCN-185) STUDY OF EXCITATIONS IN FERROMAGNETIC NICKEL. Frikkee, E. (Reactor Centrum Nederland, Petten). May 1973. 163p. Dep. NTIS (U. S. Sales Only) $10.25.

Inelastic neutron scattering experiments have been performed to investigate low-energy excitations in ferromagnetic nickel, in general, and the interaction between excitations in the electron system and lattice vibrations in particular. From the observation of "forbidden" neutron–phonon scattering it is concluded that the polarization vectors of the transverse phonons close to the Brillouin-zone boundary deviate from the directions expected in a cubic crystal. The deviations of the polarization vectors in a single domain sample can be described by means of the magnetic symmetry properties of the sample, which indicates that the perturbations are probably a result of spin–lattice interaction. In addition to the phonons and magnons, several mixed excitations were observed, which appear to possess both magnetic and vibrational properties. The energy of each of these modes is almost independent of the wave vector; their spin is probably zero. The peculiar behavior of the neutron scattering cross section may be explained qualitatively by assuming that the mixed modes are localized lattice vibrations coupled with polar electron excitations. The analysis of the experimental data is to a large extent carried out by means of group-theoretical methods. Selection rules are applied to derive the transformation properties of the perturbed phonons and the mixed modes. Some of the experimental results seem to indicate that the localized mixed modes that are created in a neutron scattering process, are not in equilibrium with the surrounding crystal lattice. (47 tables, 33 figures, 101 references) (auth)

20637 (RT/BIO-(72)19) INHERITANCE OF THE DURATION OF DEVELOPMENTAL PHASES OF THE BIOLOGICAL CYCLE OF TRITICUM DURUM DESF. Bagnara, D.; Bozzini, A.; Scarascia-Mugnozza, G. T. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [nd]. 29p. Dep. NTIS (U. S. Sales Only) $3.50.

A diallel cross among six durum wheat varieties was performed, and the results analyzed in F_1 generation. For all varieties, with the exception of 80/57, short duration resulted to be recessive for period to differentiation and dominant for period to heading; during period to maturity, some dominant alleles act towards a longer, and some others towards a shorter ripening period. In the variety 80/57, the dominance relationships appear to be reversed. (LMT)

20638 (RT/BIO-(72)50) IMMUNOCYTE INTERACTIONS IN VITRO. Doria, G.; Agarossi, G.; Di Pietro, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 9p. Dep. NTIS (U. S. Sales Only) $3.00.

It was felt that the interaction between T and B immunocytes could be highlighted by studies in vitro. The Mishell and Dutton technique (Mishell, 1967), whereby unprimed mouse spleen cells can be stimulated in vitro with sheep RBC to give rise to antibody-forming cells, was used to investigate whether the interaction between T and B cells can occur in vitro. The immune response

was evaluated by the Jerne and Nordin technique (Jerne, 1963) and expressed as number of hemolytic plaque-forming cells (PFC) per culture. Using C3HeB/Fe or DBA/2 mice, cooperation between thymocytes from normal mice and splenocytes from neonatally thymectomized mice or from thymectomized chimeras (mice thymectomized in adult life, lethally irradiated, and grafted with isogenic bone marrow cells) could be demonstrated in vitro (Doria, 1970). Similar results were obtained with (C57B1/10 × DBA/2) F1 mice in the present study. (19 references) (LMT)

20639 (SC-CR-69-3104) DEVELOPMENT OF NEW DIELECTRIC SYSTEMS TO PROVIDE A MINIMUM VOLUMETRIC EFFICIENCY OF TEN JOULES PER CUBIC INCH. Final Report, November 8, 1968–February 9, 1969. (Sprague Electric Co., North Adams, Mass.). 4 Mar 1969. 49p. Dep. NTIS $4.50.

For Sandia Corp., Albuquerque, NM.

A four-fold approach has been taken toward the goal of developing a dielectric system capability of providing an energy storage density greater than 10 joules/in^3 in a finished capacitor. These approaches were: (1) ceramic-loaded polymer dielectrics, (2) improved polymer dielectrics, (3) ceramic-loaded glass dielectrics, and (4) ceramic dielectrics. (LMT)

20640 (SC-DR–720532) TRIM-ANGLE PREDICTIONS FOR A SLIGHTLY BLUNTED CONICAL REENTRY VEHICLE WITH A FLARE-SECTION ASYMMETRY. Clark, E. L. Jr. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 20p. Dep. NTIS $3.00.

A method for theoretically predicting the nonrolling trim angle of attack of an asymmetrical reentry vehicle is described. The technique is applicable at supersonic Mach numbers for a slightly blunted, conical vehicle with a wedge-shaped asymmetry. Theoretical estimates obtained with this theory are compared with experimental data obtained at Mach numbers of 1.6 to 4.2, and the theory is shown to be adequate for design calculations. Empirical predictions for the Re-entry Vehicle Resonance Test Vehicle (RVRTV) are given. (auth)

20641 (SLA-73-172) DYNAMIC ENVIRONMENT OF VEHICLES AND VESSELS ASSOCIATED WITH ASSAULT LANDINGS. Gens, M. B. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 329p. Dep. NTIS $3.00.

Measurements were made of the dynamic environment produced by amphibious vehicles, assault boats, and a dock ship associated with the operations of an assault landing. The reduced data show relatively low amplitudes, but high incidence of discrete, intermittent, and narrow-band random excitation. (auth)

20642 (SLA-73-203) MEASUREMENTS OF LOSS MODULI THROUGH VISCOUS HEATING EXPERIMENTS. Sullivan, W. N.; Hardee, H. C. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 13p. Dep. NTIS $4.00.

This report discusses a new experimental technique for measuring the loss modulus of viscoelastic solids. The method deduces the loss modulus from measurements of the temperature rise of a sample subjected to uniaxial strain. The report presents the theoretical development and experimental results. (auth)

20643 (SLA-73-364) ANALYSIS OF UNDERWATER OPTICAL DETECTION SYSTEMS UTILIZING PHOTOLUMINESCENT TARGETS. Varnado, S. G.; Hassel, K. R. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 44p. Dep. NTIS $4.00.

An underwater optical detection system utilizing a cooperative photoluminescent target to reduce the deleterious effects of backscattering is evaluated. A comparative analysis between this system and those detecting noncooperative targets is presented. Maximum underwater detection range estimates based on theoretical signal-to-noise calculations are presented for four source–target combinations. In all four cases, the signal-to-noise ratio is found to decrease rapidly with target distance (–30 dB/attenuation length). (MOW)

20644 (SLA-73-521) AROMATIC POLYIMIDE MICROBALLOON SYNTACTIC FOAMS. Rand, P. B. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 15p. Dep. NTIS $3.00.

Polyimide microballoons (PIMB) were made by spraying a polyimide precursor solution into a tube furnace. The microballoon particle densities ranged from 0.149 to 0.561 g/cc. Syntactic foams were made with these microballoons using various polyimide binder resins, binder resin/PIMB ratios, and postcure schedules. Compression, tensile, and thermomechanical analysis tests were used to evaluate these foams. (auth)

20645 (SLA–73–585) PRESPUTTER SURFACE PREPARATION FOR RTG THERMOPILES. Traeger, R. K.; Knauss, G. L. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 27p. Dep. NTIS $3.50.

The results of development studies leading to cleaning procedures for production processing are reviewed. The recommended procedures include lapping and polishing the thermopile surfaces to a ¼-μ finish; with a final ultrasonic cleaning sequence using isopropyl alcohol, detergent solution, water, and a final alcohol rinse just prior to sputtering. A hydrofluoric acid etch is probably desirable to provide a consistent surface oxide for subsequent tungsten contact deposition. (auth)

20646 (SLA-73-673) COOLING OF NEWTONIAN AND NONNEWTONIAN FLUIDS WITH TEMPERATURE-DEPENDENT VISCOSITY. Cochrane, G. F. (New Mexico Univ., Albuquerque). Dec 1972. 29p. Dep. NTIS $3.50.

For Sandia Labs., Albuquerque, NM.

Heat transfer rates and pressure drops are predicted for cooling of Newtonian and nonNewtonian fluids with temperature-dependent viscosity in pipe flow. A numerical solution previously developed for heating of Newtonian and nonNewtonian fluids was converted for use with the IBM 360 computer. Computations were made to predict heat transfer and pressure drop data for cooling conditions. In a cooling situation the pressure drop for a fluid with temperature-dependent viscosity is predicted to be much greater (often two to three times as great), and the heat transfer rate is predicted to be only slightly less than for a fluid with temperature-independent viscosity. (auth)

20647 (SLA-73-739) COMPRESSED-AIR ACCELERATOR INSTALLATION FOR MODEL PARACHUTES. Braun, G. (comp.) 1973. Translation of IB-154-73/2. 29p. Dep. NTIS $3.50.

The installation, which includes a compressor, breech mechanism, lock, accelerator section, and breaking section with exhaust unit, is described. The parachute system, the transducers, and the telemetry unit are accommodated in the test missile, which is also described. Results of test operations of about one year are briefly discussed. (15 figures) (LMT)

20648 (SLA-73-795) IMPEDANCE MATCHING IN MICROWAVE MICROELECTRONICS. Raev, M. D.; Shvarts, N. Z. Translated from Izv. Vyssh. Ucheb. Zaved., Radioelektron.; 15: No. 6, 728-738(1972). 19p. Dep. NTIS $3.00.

Design characteristics of microstrip matching lines in integrated microwave systems are considered. The matching problem of arbitrary two-element impedances by means of the simplest matching circuits is solved. Frequency characteristics of such circuits are investigated. General formulas for the values of elements in the matching circuits are derived, as well as the restrictions on the parameters of the load impedances to be matched and approximate formulas for the transmission bandwidth. (auth)

20649 (SLA-73-5294) ANALYSIS OF DEPLOYMENT AND INFLATION OF LARGE RIBBON PARACHUTES. McVey, D. F.; Wolf, D. F. (Sandia Labs., Albuquerque, N. Mex.). 1973. 13p. (CONF-730523-2). Dep. NTIS $3.00.

From aerodynamic deceleration systems conference; Palm Springs, California, USA (21 May 1973).

A method for predicting deployment and inflation of reefed ribbon parachutes is presented. The method is based on integration of axial and radial momentum equations developed in the paper. Axial and radial forces are assumed to be describable by drag and radial force coefficients. Computer solutions of the equations are compared to measured parachute loads and to parachute mouth and maximum diameters from tests of 23- and 76-ft diameter conical ribbon parachutes. Comparison of load histories indicates that snatch loads depend to a large extent on deployment bag design and packing influences. Computed loads and parachute size histories for the inflation process compared favorably with flight data. The concept of a radial force coefficient appears to have considerable merit as a means of computing inflation for most types of parachutes. (auth)

20650 (SLL-73-249) FINITE-CONDUCTANCE-ELEMENT METHOD OF CONDUCTION HEAT TRANSFER. Lemmon, E. C. (Sandia Labs., Livermore, Calif.). Jun 1973. Contract AT(29-1)-789. 103p. Dep. NTIS $7.25.

A new finite-conductance-element method developed for solving complex heat conduction problems. It offers the simplicity of the standard finite-difference method with the finite-element-method advantages of easily handling irregular boundaries and superposition. (auth)

20651 (TID-26366) SCIENTIFIC AND TECHNICAL MANPOWER REQUIREMENTS OF SELECTED SECTORS OF THE ATOMIC ENERGY FIELD. Final Report. Voigt, K. L. (American Nuclear Society, Hinsdale, Ill.). 19 Aug 1970. Contract AT(11-1)-2016. 264p. GPO $2.00.

20652 (UCID-15420) CREEP PROPERTIES OF PLASTICS FOAMS. Lepper, J. K.; Hetherington, N. W.; Hammon, H. G. (California Univ., Livermore. Lawrence Radiation Lab.). 1968. Contract W-7405-eng-48. 32p. Dep. NTIS $3.75.

The study of the creep properties of plastics foams provides data on time- and temperature-dependent properties. Some creep properties of rigid polystyrene bead foam, and the techniques used to obtain the data were described. It was shown that the creep behavior could be fitted to a power law equation of the form $\epsilon = \epsilon_0 + mt^n$, and that the rate of creep (n) was found to average 0.1168 (slope of log ϵ vs log time in hours). The creep deflection could also be described within the scope of the previous experiment by a Taylor series expansion through the second order terms of a function of applied load, temperature, and density. Data on the long-term creep of polystyrene bead foam, commercial polypropylene foam, and three low-density (about 0.03 g/cc) urethane foams are summarized. These materials were exposed to loads of from 2 to 10 psi at temperatures from 23 to 78°C. (MCW)

20653 (UCLA-12-805) ENERGY METABOLISM OF FOUR SPECIES OF DESERT RODENTS IN THEIR NATURAL ENVIRONMENTS. Mullen, R. K. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Jan 1971. Contract AT(04-1)-Gen-12. 91p. Dep. NTIS $6.75.

20654 (UCLA-34-P-8-X-5) STUDY OF PLANT VIRUS AS APPROACHED THROUGH THE STUDY OF NORMAL PLANT PROTEINS. Progress Report, May 31, 1972–June 1, 1973 and Future Plans for 1973–1974. Wildman, S. G. (California Univ., Los Angeles). 1973. Contract AT(04-3)-34. 13p. Dep. NTIS $3.00.

20655 (UCRL-51383) TWO-ZONE POTENTIAL RELAXATION SCHEME FOR HANDLING GRID WIRES. Smith, R. R.; Rompel, S. L. (California Univ., Livermore. Lawrence Livermore Lab.). 1 Jun 1973. Contract W-7405-eng-48. 19p. Dep. NTIS $4.00.

A relaxation scheme for economically calculating two-dimensional electrostatic potentials in configurations with fine grid wires was devised and tested. Potentials calculated in this manner agree with potentials calculated with an analytic formula for the case of a one-wire test problem in which the radius of the wire is two orders of magnitude smaller than the outer boundary dimensions. (auth)

20656 (UCRL-73057) SIMPLE CONSTITUTIVE RELATION FOR POROUS MATERIALS. Holt, A. C.; Carroll, M.; Kusubov, A. (California Univ., Livermore. Lawrence Radiation Lab.). 1 Mar 1971. 23p. Dep. NTIS $3.25.

A mathematical model is developed for the stress and thermal response of porous materials, and it is explained how this model can be implemented into a finite-difference code for describing stress-wave propagation. The model is different from the widely used "P-α" model for porous materials in that the pressure in the porous material is related to the pressure in the matrix material by means of the equation $P = p_s/\alpha$, instead of the older form $P = P_s$, which holds approximately only if the pressure in the pores is nearly equal to the pressure in the matrix. Also provided for is a finite relaxation time for response of the pores to an applied pressure. auth

20657 (UCRL-74260(Rev.1)) DEPENDENCE OF ACOUSTIC EMISSION OF STRAIN RATE IN 7075-T6 ALUMINUM. Hamstad, M. A.; Mukherjee, A. K. (California Univ., Livermore. Lawrence Livermore Lab.). 29 Jun 1973. 22p. (CONF-730511-4). Dep. NTIS $3.25.

From 3rd international congress on experimental mechanics conference; Los Angeles, California, USA (14 May 1973).

The dependence of RMS acoustic emission output on strain rate was determined during tensile tests on 7075-T6 aluminum over a range of strain rates from 0.015 min^{-1} to 0.230 min^{-1}. A special normalization technique was developed to eliminate the inherent differences in the acoustic emission from supposedly identical specimens tested under identical conditions. It was found that the RMS acoustic emission output increases approximately linearly with strain rate, and that the slope of the linear dependence decreased with increased plastic strain. The effect of pinned dislocation breakaway on the acoustic emission output versus plastic-strain relationship is the subject of a preliminary theory. (auth)

20658 (UCRL-Trans-10694) FORMAL KINETICS OF REACTIONS OCCURRING IN PHOTODISSOCIATION GAS LASERS. Skorobogatov, G. A. Translated from Vestn. Leningrad. Univ., Ser. Fiz. Khim; No. 4, 144-157(1970). 24p. Dep. NTIS $3.25.

Formal kinetics of the reactions occurring with various possible mechanisms of quenching stimulated emission were considered for gas lasers based on the electronic transition $A^1 \rightarrow A^0 + h\nu$ with a photodissociation mechanism of the production of the atoms A^1. The operation of a gas laser based on the transition $I(^2P_{\frac{1}{2}}) \rightarrow I(^2P_{\frac{3}{2}})$ was used as an example. (auth)

20659 (UCRL-Trans-10700) CHARACTERISTICS OF KURILE–KAMCHATKA EARTHQUAKES AS OBSERVED FROM NEARBY STATIONS DURING THE PERIOD 1952–1954. Monakhov, F. I.; Tarakhanov, R. Z. Translated from Izv. Akad. Nauk SSSR, Ser. Geofiz.; No. 5, 401-415(1955). 29p. Dep. NTIS $3.50.

20660 (UR-3490-293) PROTEINS OF THE T4 BACTERIOPHAGE REPLICATION APPARATUS. Barry, J.; Hama-Inaba, H.; Moran, L.; Wiberg, J.; Alberts, B. (Princeton Univ., N. J. Dept. of Biochemical Sciences; Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1972. 39p. (CONF-720689-1). Dep. NTIS $4.00.

From conference on DNA synthesis in vitro; Madison, Wisconsin, USA (Jun 1972).

20661 (Y-1887) CALCULATED X-RAY DIFFRACTION DATA FOR POLYMORPHIC FORMS OF CARBON. Holcombe, C. E. (Oak Ridge Y-12 Plant, Tenn. (USA)). 23 Jul 1973. Contract W-7405-eng-26. 17p. Dep. NTIS $4.00.

Theoretical x-ray powder-diffraction patterns (flat absorption) were calculated for the several forms of carbon for which crystal data are available or can be derived. These polymorphic forms both possible or known) are either graphite-related or diamond-related, and are based on different stacking sequences of planes of carbon atoms. (auth)

20662 (Y-JA-96) EXPERIMENTS WITH SPRINKLER HEAD CANOPIES FOR FIRE PROTECTION. DeMonbrun, J. R.; McCormick, J. W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 2 Jul 1973. Contract W-7405-eng-26. 8p. Dep. NTIS $3.00.

20663 MYOGLOBIN, VITAMIN B-12 COENZYME AND POLY-L-ALANINE (ENGINEERING MATERIALS). (CAPE-2349). 16 drawings.

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